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PRESERVATION OF THE COUNTRYSIDE

THE National Parks and Access to the Countryside Bill introduced in the House of Commons on March 17 has been long awaited—indeed so long that many despaired of seeing anything done. The appointment of a National Parks Commission, with wide duties, will mark an important step forward.

The announcement by the Lord President of the Council on February 11 of the establishment of the Nature Conservancy followed hard on an adjournment debate in the House of Commons in which the attitude of the Minister of Town and Country Planning had indicated the Government attitude towards Nature conservancy, national parks and the preservation of flora, fauna or scenic beauty. This debate, on quarrying in the Peak district of Derbyshire, on February 7, was admittedly held at an hour when the House of Commons is not normally well attended. Even so, the presence of only half a dozen members was as discouraging to those who are anxious for the effective preservation of Britain's dwindling resources of scenic beauty, flora and fauna as was the reply given by the Minister of Town and Country Planning. Mr. Silkin's inclusion as member of the reconstituted Committee of the Privy Council for Agricultural Research and Nature Conservation may possibly educate him as to the wider issues, but his conversion may have little effect if the House continues to be apathetic to the preservation of amenities or scenic, cultural or scientific values, and is interested only in the economic exploitation of physical resources to the exclusion of considerations of recreation, health and beauty. The New Forest Bill at present before the House of Lords makes no provision for preventing damage to areas of scientific importance. That Bill also contains two clauses which permit the enclosure of a further 5,000 acres for timber-growing and 3,000 acres for agriculture. Strong objection has been made to both clauses as detrimental both to commoners' rights and to public amenity, and it has also been urged that the Bill permits road construction with insufficient regard to amenity.

The occasion of the debate on February 7 was the approval by the Minister of the great extension of the existing cement works in the Hope Valley, an approval which was challenged in forthright terms by Mr. H. Molson, member for the High Peak division, as a grave dereliction of duty. Instead of holding the Peak district in trust against the day when it becomes a national park, the Minister has permitted great harm to be done to the amenities of the Hope Valley. Apart altogether from the merits or demerits of the proposal to insist on the use of something in the nature of the Lodge–Cottrell precipitator to mitigate the dust nuisance as a condition of the extension, or of the possibility of replacing the proposed 400-ft. chimney by a 200-ft. chimney, it is clear that the Minister has neglected the comprehensive examination of mineral development in the

vicinity of Buxton and the High Peak which he began in November 1946, and that he has no general plan upon which to work when dealing with individual applications for development which are already alarmingly numerous.

This is the real point of the indictment, which is not wholly met by the Bill just introduced. Mr. F. Marshall, formerly of the Ministry of Town and Country Planning, indicated very clearly the importance of the Hope Valley to the proposed national park of the Peak, and the way in which the cement works is already destroying the beauty of the valley. Protests from the Sheffield and High Peak members were supported by others on behalf of the citizens of Nottingham, Derby and Leicester. In replying, the Minister declined to reconsider his decision; but he stressed the determination of the Ministry to see that in this and in any future workings, not only should restoration be effected so far as possible while working continued, but also the actual working should be carried out in the least injurious manner.

Restoration or palliation, though welcome, is not, however, the particular point at issue. Somewhat injudiciously, perhaps, Mr. Molson had also referred to the great destruction in Ashwood Vale which the Minister is permitting without proper opportunity for public inquiry. This charge was irrelevant to one of dereliction of duty in regard to a national park area; but Mr. Silkin dismissed it all too summarily, particularly in view of the recent transfer from the regional planning controllers to the local planning authorities of the responsibility for notifying interested parties of proposals under consideration. The regional planning controllers have been scrupulous in informing such bodies as the amenity societies at an early stage, and it cannot be too strongly emphasized that early information is essential if such societies are to state their case effectively and advance constructive proposals with the best chance of success.

There is no evidence that the Minister has laid on the local authorities a like responsibility; but what stood out most clearly from this debate is not simply a lack of zeal or will but a lack of power on the part of the Government. The Minister of Town and Country Planning has the invidious, if not impossible, task of being required as a departmental Minister to decide between competing departmental and other claims to the use of land for training purposes, amenities, industry, agriculture, water-supply, mineral workings, housing, etc. He has not the authority to resist the claims of another department, being only *primus inter pares*. The balancing of such conflicting claims can only be done at Cabinet level, and in the absence of such a Cabinet committee as has been repeatedly urged in these columns the piecemeal destruction of Britain's scenic heritage, her flora and fauna and her amenities for recreation and health will continue apace.

There have been repeated instances of this danger in recent months. The Government has approved, for example, the War Department's proposals to use 1,100 acres of land, with a sea danger area, at Ross Links, Northumberland, as an anti-tank gun range, in spite of the proximity of Holy Island, the bird sanctuaries at Ross Links and the Farne Islands and of the historical associations of the district. It is held that the range will not have any serious effect on the bird sanctuaries; but that is a point which might well have been left for the Nature Conservancy to determine. Similarly, the opposition of between forty and fifty local authorities and interested bodies at a public inquiry into proposals by the War Department and the Ministry of Supply to requisition 1,660 acres of Cannock Chase for a Territorial Army training area and a tank-testing ground appears to have been fruitless, departments once again being allowed to judge their own cause.

The decisions announced earlier by the Ministry of Town and Country Planning regarding the War Department proposals for the use of Fylingdales Moor and Redesdale will likewise undermine public confidence in the Ministry's power or determination to safeguard amenity. The area to be used under the former proposal has indeed been reduced by a 950-acre coastal stretch to 28,190 acres; but the application was resisted by all the local authorities concerned, as well as by the National Farmers' Union and the Council for the Preservation of Rural England. The extension of 5,700 acres to the Redesdale artillery range, which has been approved, subject to boundary readjustments and provisions in the interests of ramblers and climbers, cuts across the Pennine Way and into the area proposed for a Cheviot National Park in the Dower Report. This consistent failure of any of the public inquiries into training areas proposed in potential national parks to secure a decision in favour of the objectors only confirms the impression that departments are allowed to judge their own cause.

Nor has the Ministry of Town and Country Planning shown itself any more alert in the defence of villages such as Letcombe Bassett, where what is at stake is the preservation of an ancient village community. The Ministry does not appear to have intervened even to the extent of referring the proposed destruction to its own advisory Committee on Historic Buildings. The security of much of the beauty of the valleys of North Wales, like the continued freedom of the Lake District from overhead lines, has depended on the reasonableness of the British Electricity Authority rather than on any authority or intervention of the Ministry itself. Even such reasonableness has not prevented the formulation of proposals such as that which would have destroyed the beauty of Guy's Cliffe, Warwick, by erecting a generating station at Hill Wootton, although six alternative sites are stated to be available. This particular proposal was promptly repudiated by the British Electricity Authority. The Council for the Preservation of Rural Wales did well to sound a warning, in its annual report, against the idea that the vigilance of its members can be relaxed now that the Town and Country Planning Act has become law. At the annual meeting of the Council at Bangor on January 14, determined but constructive opposition was manifested to features of the power scheme for North Wales, which would turn

the Snowdon area into a gathering ground and make a travesty of the idea of a national park.

One of the most encouraging features of the last year is indeed the increasing alertness of the local authorities to the claims of amenity and beauty; and now that the struggle to see that such claims are not thoughtlessly and invariably overridden by the claims of utility is transferred to a new arena, such vigilance will be an important factor in enabling the amenity societies to make effective representations, when the Minister of Town and Country Planning places on the local planning authorities the responsibility which was formerly so scrupulously discharged by the regional planning controllers. This tendency is illustrated by several protests made against the Halifax Corporation Bill, which seeks powers to build a reservoir in the Hebden valley and involves a property only recently given to the National Trust by Lord Savile. The West Riding County Council and the Hepton Rural Council have united with the Hardcastle Crags Preservation Society in opposition which is regional even more than local. Again, at a recent conference to consider the War Department's claims for Angelzarke moors or Hailstorm Hill in Lancashire as training grounds for the Territorial Army, eight local authorities, together with two water-boards and two planning boards, were united in opposition. The second site had the support of the Lancashire branch of the Council for the Preservation of Rural England in a comparative statement. The conference indicated the need for a competent authority, such as the proposed National Parks Commission, at a much higher level which could take an independent view and decide between competitive needs on national and not on sectional grounds.

The National Parks Commission, moreover, should do much to remove the misunderstandings and bitterness which is at present arising between the agricultural interests and those of industry, water-undertakings and urban expansion. The new towns policy and the more effective planning of the use of land has, in fact, already decreased the risk of waste of agricultural land. Nevertheless, the extension of iron ore excavation in Northamptonshire is a source of growing concern to agriculture in a county which has in this way already lost 3,000 acres of rich farm land in the last fifteen years, and has another 60,000 acres threatened by applications in the hands of its planning officer. Here again it is understood that the whole matter is being considered by a committee representing all interests which has been set up by the Minister of Town and Country Planning, and which will have in mind the possibilities of restoration. The steel firms have already joined with the War Agricultural Executive Committee in an experiment which seeks to establish whether a fertile topsoil can be created by the use of artificial fertilizers on a 'valley' site of thirty acres near Corby.

It can no longer be contended that opposition to the proposals for training areas, water-power and other development schemes is factitious and unconstructive. There is no evidence that the Services have ever considered the joint use of training areas, or that in spite of the White Paper any attempt has been made by the individual Services to co-ordinate their own demands. The Minister of Defence has failed, or refused, to use his authority to see that Service demands are properly sifted and co-ordinated before they are submitted to an interdepartmental committee at all; and meanwhile it is evident that the Minister of Town and Country Planning is as incapable of resisting piecemeal demands and encroachment as he is, in the absence of a real policy of industrial location, of giving a clear lead to local planning in such industrial areas as the Hartlepools or the West Midlands.

The publication of the survey and plan for the Hartlepools has strikingly revealed the weaknesses of that aspect. The Government is still attempting to pursue two conflicting and incompatible policies; for whereas the planning of industrial location is essentially a national and regional function, the planning of where people are to live is in the hands of local authorities. Until the Government finally determines which policy for industrial location it means to pursue, and until regional planning authorities are established, much of the excellent work being done by town-planners will continue to be misdirected, and the waste of agricultural land, amenity and scenic beauty will be enhanced.

The absence of a central policy is the real danger in this whole question of national parks, land use and amenity. In its last annual report the National Trust emphatically endorses the view that the stronger and the more independent the national parks commission can be made, the more likely are the national parks to be a success. Furthermore, the Council of that body expresses the hope that legislation to establish a Nature Conservation Board and a Biological Service and to set up the whole organisation for national parks will be based upon the excellent reports from the Hobhouse and the Huxley Committees; a preliminary consideration of the new Bill suggests that, in the main, this has been done.

It is manifestly unfair and unwise to expect local authorities to take a national, or even a regional, view in the administration of national parks, to maintain uniform standards and to resist encroachment of other interests often of more influential national bodies or State departments; but there is no lack of opportunity for local interest and support, if amenity is to be preserved and the national parks and Nature reserves are to serve their purpose. The National Trust in the report already quoted appeals for local support in raising the standard at which National Trust properties all over Britain are maintained, and the report of the Council for the Preservation of Rural Wales, directing attention to the need for a well-informed body of public opinion, notes that in at least three Welsh counties representatives of the Council have already been nominated and accepted as members of the county planning committees.

A number of factors have no doubt contributed to the delay in the appearance of the National Parks Bill, one of them being the apparent lack of decision

by the Government regarding the urgency of the situation. Meanwhile, as has been shown above, the piecemeal process of dealing with individual areas as the need arises and with little evidence of any guiding principles has led to encroachment and general dissatisfaction. It is to be hoped that the new Bill will quickly become law, and a strong National Parks Commission be set up which will be able to afford the Minister of Town and Country Planning authoritative advice. Provided he is supported effectively at the highest levels of the Government, and with the aid of the Nature Conservancy and its Biological Service, an important step forward will have been taken towards safeguarding the dwindling reserves of the flora, fauna and scenic beauty of Britain.

A THEORY OF PROBABILITY

Theory of Probability

By Prof. Harold Jeffreys. (International Series of Monographs on Physics.) Second edition. Pp. viii + 412. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 30*s*. net.

THE first edition of this now famous treatise appeared in 1939, and the review in *Nature* in the following year by Mr. M. G. Kendall gives a good account of the theory developed by Prof. Jeffreys. I shall therefore give here only a general comment on the point of view adopted in the work, while noting also some of the new features of the present edition.

To many to-day it appears that the classical 'calculus of probabilities' needs to be separated into two quite distinct components:

(1) *The theory of uncertain inference.* This may be described as an extension of traditional logic; in it a probability-number is a numerical measure of the degree of 'reasonable' belief in some proposition, in relation to a given body of evidence. One role of the theory is the provision of a critique of the whole of natural philosophy, and in particular it is relevant whenever a mathematical model is selected for the description of some physical or biological situation, and also whenever a 'prediction' made with the aid of such a model is to be interpreted in relation to one's belief about the real world.

(2) *The theory of chance phenomena.* Not all empirical situations can be appropriately described by mathematical theories of the deterministic type used, for example, in classical mechanics, and sometimes it appears more appropriate to employ a mathematical model involving the notions of random variable and random process. Here a probability-number between 0 and 1 is an ideal element of the model which corresponds in the 'real' world to the value which an observed frequency-ratio appears to be approaching as the number of trials is increased, while a probability-number equal to 0 or to 1 corresponds to 'practical' impossibility, or certainty, respectively. It is these two 'conventions of interpretation' which are used to relate a particular model of this kind to the corresponding empirical situation. The decision to construct such a model for a particular situation will, of course, only be made if the observed frequency-ratios do appear to approach stable values. Accordingly, the fact that the model itself admits a representation of an infinite sequence of trials raises an important question of consistency which is answered satisfactorily by the theorem known as 'the *strong* law of large numbers'.

It follows, if this analysis be accepted, that the theories (1) and (2) should be developed independently; and that (2) shares with every other branch of natural philosophy its relationship to (1). Moreover, (2) will retain its significance even for those who reject some particular (or every) attempt to give a rigid form to (1).

Prof. Jeffreys has provided us with a theory of inference; but he appears to refuse to the mathematical theory of chance phenomena an independent status. This seems to me unfortunate, especially as (2) is more important to the man of science than (1) if he is content to make the inferences relating theory to practice in a manner at once more personal and less formal than that advocated in the work under review.

It might be held that while the notion of chance appears to be an essential element in our description of the world, it is really a reflexion of our own ignorance. If this view is correct, the theory (2) must have its place within the framework of (1); but it would presumably still retain a self-contained validity as a mathematical description of what is observed. Epistemology is likely to lag behind the descriptive achievements of natural philosophy, and accordingly the independent development of a theory of chance phenomena would still seem to be worth while. Prof. Jeffreys, however, will have none of this, for he remarks that "the essence of the present theory is that no probability, direct, prior, or posterior, is simply a frequency".

Of the new features of the second edition of this book, the most interesting is the author's account of his 'theory of invariance'. The aim of this is the provision of a universal basis for the formal description of ignorance needed in the treatment of the problem of estimation by the methods of inverse probability. In the first edition, an unknown location parameter, θ, of unrestricted range was given a prior probability proportional to $d\theta$, while an unknown scale parameter θ of range $(0, \infty)$ was given a prior probability proportional to $d\theta/\theta$. Both the arbitrariness of this procedure, and its lack of invariance for functional transformations of the parameter, have been much commented upon; the theory of invariance goes a long way towards removing one of these objections by providing a rule for the prior probability, which remains unchanged in form for all non-singular transformations of the parameter. The following remarks will illustrate its working in a simple case: let

$$\varphi(x;\theta)\,dx \qquad (-\infty < x < \infty)$$

be the probability distribution for a single observation; then if the prior probability for the range of parameter-values $(\theta,\ \theta + d\theta)$ is taken to be proportional to

$$\left\{ \int_{-\infty}^{\infty} \frac{1}{\varphi} \left(\frac{\partial \varphi}{\partial \theta} \right)^2 dx \right\}^{1/2} d\theta, \qquad (1)$$

the required invariance property will obtain, and when the parameter is one of scale or of location the earlier rules follow as special cases.

An extension of the rule to multi-parameter problems is given, but Prof. Jeffreys stresses the

need for further investigation. It seems likely that the methods he has introduced here will also suggest interesting developments in other approaches to the problem of estimation; thus the integral occurring in (1) plays an important part in Prof. R. A. Fisher's theory of 'statistical information', while (following suggestions by Dianandа and Perks) some comments are made in the present work on the relation of maximum likelihood to invariance theory.

The book concludes with a number of new tables and with an appendix on the consistency of the product rule. The first edition contained a very useful appendix on the properties of the factorial (that is, gamma) function; this has been omitted, but an equivalent account has been published separately (in "Methods of Mathematical Physics").

Only to those few who are not familiar with the 1939 edition need it be said that this is a profoundly interesting book of the greatest originality. No one who is seriously interested in the subject can afford not to read it.

DAVID G. KENDALL

A TEXT-BOOK ON FUNGI

The Fungi

By Frederick A. Wolf and Frederick T. Wolf. Vol. 1. Pp. x + 438. 36*s*. net. Vol. 2. Pp. xii + 538. 39*s*. net. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, 1947.)

THERE is a great demand among university students in botany for modern text-books dealing with the fungi. Broadly speaking, two works are needed: a relatively small book dealing briefly but clearly with the morphology and reproduction and also discussing the physiology, ecology and cytogenetics of fungi, and a larger work, probably running into several volumes, dealing with the structure, reproduction and taxonomy of fungi along the lines of Fritsch's classic on algæ.

The publishers' announcement heralding the appearance of F. A. Wolf and F. T. Wolf's two volumes led many teachers of botany to hope that this new work would satisfy a very real want; unfortunately, the books have proved a disappointment. Volume 1 is so different from volume 2 that a reviewer must treat them separately. The former aims at giving the student a picture of the developmental morphology and classification of fungi. Clearly, in 438 pages it is not possible to be exhaustive, and the authors have deliberately omitted certain families; but the omission of all reference to Drechsler's beautiful work on Zoopagaceæ and to Winge's classic researches on haplophase and diplophase in yeast are difficult to excuse.

It is the modern fashion to condemn the 'type' method in teaching, and certainly Wolf and Wolf are modern in this respect. From their book it would certainly be very difficult for the student to gain any really clear picture of the structure and life-history of any single fungus. This difficulty is increased by the fact that the numerous black-and-white illustrations are merely scattered about the text as decorations, the authors having deliberately refrained from making reference to them in the text. Perhaps the best part of volume 1 is the treatment of the Ascomycetes; but in the Basidiomycetes the Hymenomycetales are dismissed in twenty pages and, instead of a careful comparative account of structure and development, the student is presented with a very inadequate discussion of the characters used in the delimitation of genera. Again, the section on Phycomycetes leaves much to be desired, and there are errors both in the figures and in the text. We are told that the chytrids are characterized by anteriorly uniflagellate zoospores; bi-flagellate zoids are seen escaping from the zoosporangium in Fig. 22 which represents *Blastocladia*, and the structure of the sporangium of *Rhizopus* (Fig. 35) is distinctly odd.

The mycologist having perused volume 1 turns with relief and hope to volume 2, since the list of chapter headings gives real promise. This volume consists essentially of a series of essays on mycological subjects, such as: nutrition of fungi, biochemistry of fungi, spore dissemination, germination of spores, host penetration, physiological specialization, mycorrhiza, genetics of fungi, poisonous and edible fungi, medical mycology, soil fungi, fungus-insect relationships, marine fungi and fossil fungi. Each essay has a good list of literature at the end, and these lists probably represent the most useful part of the whole work. But the essays themselves are disappointing, and errors are easy to find. It would have been better had the authors discussed fewer topics in a more careful and discriminating manner.

The volumes are well printed, strongly bound and the text-figures are clear; but, even if the work could be recommended to students, the price is much too high.

C. T. INGOLD

SELECTED PAPERS OF C. O. JENSEN

Selected Papers

By C. O. Jensen. (Published at the expense of the Rask-Ørsted Foundation.) Vol. 1: 1886–1908. Edited by M. Christiansen and H. O. Schmit-Jensen. Pp. xvi + 681 + 14 plates. (Copenhagen: Einar Munksgaard, 1948.)

THIS collection of papers represents the scientific activities of C. O. Jensen during 1886–1908, and is to be followed by a second volume covering the period 1909–33. Thirteen of the papers which were originally published in Danish have been translated into excellent English. The remainder are reprints in German and one in French.

Most of the work was done in the Bacteriological Department of the Laboratory for Agricultural Research, Copenhagen. A short biography, in English, by M. Christiansen, adds point to the collection. A period of three years illness forced Jensen to give up his veterinary practice and take a sedentary job in bacteriology, and this greatly influenced his scientific career. He was fortunate in having for his teachers Salomonsen, who also trained Fibiger, with whom Jensen was associated in several investigations, and for a time in Berlin, Robert Koch.

Jensen succeeded Bang, and for forty-five years lectured on bacteriology and serology. Living at a time when bacteriology was making rapid strides, it is not surprising that Jensen was able to produce a great many valuable papers on milk control and various animal diseases. To the medical reader, the greatest interest probably will centre on his advocacy of pasteurization and hygiene in the dairy industry. Jensen identified the causes of the turnip flavour in milk and butter, which he showed to be due not, as then believed, to the cows' diet but to contamination

of the milk after milking by various specific bacteria. He saved the Danish dairy industry a great deal of money, and made notable contributions to public health and to veterinary science. A period of collaboration with Fibiger helped to establish the relationship of human and bovine tuberculosis. To the writer, however, Jensen's work on experimental cancer is of the greatest interest. This subject is covered by six papers, five of which are translated into English from the original Danish.

Jensen established a number of transplantable tumours of mice and a transplantable sarcoma of the rat, generally called the 'J.R.S.', which is still widely used because of its consistent biological characteristics.

Many of the now well-known properties of tumour cells were first described by Jensen, who showed experimentally that they could not resist temperatures above 46° C., actinic light from a Finsen lamp with adequate cooling of the tumour tissue, drying and autolysis, and, in fact, that cancer cells had general properties very similar to those of normal cells. He failed to demonstrate any infective or parasitic causal factors associated with his transplantable tumours. In a lecture on "Some Experiments with Cancer Tumours" in 1901, Jensen discussed the etiology of cancer in terms that are equally apposite to-day.

Jensen's objective attitude towards his own work is well illustrated by his frank admission in a paper (1908) that his earlier claims, in 1905, to have caused regression of transplanted tumours by injection of antiserum obtained from rabbits immunized against mouse tumour were ill-founded, and that the regressions were probably spontaneous.

Jensen recognized the desirability of investigating the incidence of spontaneous tumours in the progeny of mice bearing spontaneous tumours. He attempted some experiments on these lines; but as the significance of line breeding was not then appreciated, his results were less striking than those of modern geneticists.

This collection of papers is an example of consistently good experimental work, lucidly expounded.

P. R. Peacock

SPECTROSCOPY AND ITS APPLICATIONS

Spectroscopy and Combustion Theory

By Dr. A. G. Gaydon. Second edition, revised. Pp. xii+242. (London: Chapman and Hall, 1948.) 25*s.* net.

Hyperfine Structure in Line Spectra and Nuclear Spin

By Prof. S. Tolansky. (Methuen's Monographs on Physical Subjects.) Second edition, revised and enlarged. Pp. viii+120. (London: Methuen and Co., Ltd., 1948.) 6*s.* net.

BOTH these books are revised second editions of well-known and valuable monographs. They deal with the detailed application of experimental and theoretical spectroscopy to the specialized problems of chemistry and physics. Both are written by acknowledged authorities in their respective fields, and contain fairly complete reviews of the original contributions of the authors.

Combustion processes are extremely fast chemical reactions, and kinetic studies have shown that many are chain reactions involving the intermediary participation of atoms, radicals or energy-rich molecules. Direct measurements of the nature, formation and reactivity of these active particles are not straightforward, and it is in this field that spectroscopic studies can reveal much information not obtainable in other ways. In his monograph, Dr. A. G. Gaydon has summarized the progress that spectroscopic research has made in the study and elucidation of the finer details and mechanism of the combustion process. Much of the material is the original work of the author, and in preparing the second edition the book has been considerably expanded and brought up to date by the inclusion of new material. Those who found the first edition valuable will not hesitate to read this new modernized version. To others interested in combustion the book can be warmly recommended as a most stimulating work and the only book which summarizes the great advances which the application of theoretical and experimental spectroscopy have made to the theory and nature of combustion. The subject-matter is presented in an elegant, precise and readable manner, and no detailed previous knowledge of spectroscopy by the reader is assumed. The early chapters, which deal with the study of the emission spectra of various flames and explosions, are followed by chapters devoted to continuous spectra, the role of atomic oxygen in flames, and the use of absorption spectra and investigations in the infra-red region in studying combustion processes. Later chapters are devoted to special topics such as after-burning, determination of flame temperatures, and the life-time of activated molecules. In the last section the author indicates possible future developments and the nature of the problems yet to be elucidated. A fairly complete bibliography and an appendix, giving the chief characteristics of the flame spectra which have been studied, are included and have enhanced the value of the work as a reference book.

Prof. S. Tolansky's small book is one of the well-known series of monographs on physical subjects published by Messrs. Methuen. It is intended for students who are already familiar with the fundamentals of atomic spectroscopy and who wish to enlarge their knowledge and become familiar with the important developments which have arisen from the detailed study of the theoretical and experimental aspects of the hyperfine structure of line spectra. Since the first edition of this work, considerable advances have been made, and these are included in several new chapters and by the extensive rewriting of other sections of the book. Because the hyperfine structures of the spectral lines are due to either isotopic mixture or spin properties of their nuclei, recent developments have been largely concentrated on providing information about nuclear and magnetic moments. It is with this aspect that the book is mainly concerned. The determination of these magnitudes is summarized in a clear and concise manner, and an up-to-date list of nuclear data of some fifty-five different atoms, including seventy-nine isotopic species, is provided and discussed. An adequate theoretical background for the understanding of the hyperfine structure is given.

The advanced student or others interested in either spectroscopy or nuclear structure will find this book easily readable and useful. It can be thoroughly recommended as an excellent introduction to the subject.

The Cinnamon Bird

By R. M. Lockley. Pp. 79+4 plates. (London: Staples Press, Ltd., 1948.) 8*s*. 6*d*. net.

R. M. LOCKLEY is one of the best-known of British naturalists. He is an accurate observer, and his prose is so good that any book of his is pleasant to read, even by those who have little knowledge of the subjects on which he writes. In "The Cinnamon Bird" he tells of an experiment made of taking a dozen marked canaries from captivity to his small, wind-swept island of Skokholm in the Irish Sea, a home of shearwaters and an alighting place of many migrants. Here the small birds were gradually given full liberty, and the record of their lives on the island during the spring, summer and autumn is set down. By September the population of canaries had increased, and the young birds flew over the island in little flocks or 'charms', happy and carefree. But in September came disaster, for the island is visited each year by numbers of sparrow hawks, and these gradually thinned the numbers of the canaries until those which were not caught and housed once more had all been killed. One of the canaries had a brief mating with a migrating goldfinch, which next morning left the island. She laid four eggs, but only one hatched. The hybrid was a cock, a beautiful and strong bird, with a rich song differing slightly from a canary's song. One of the most moving passages in the book describes the son's furious pursuit of the hawk which killed his mother. There are four excellent illustrations in colour by C. F. Tunnicliffe, which are admirably reproduced, and the printing and appearance of the book generally are unusually good. In this short notice I have been able only to touch on the book's contents, which will be read with appreciation by R. M. Lockley's wide circle of admirers.

SETON GORDON

Compendio y descripción de las Indias occidentales

Por Antonio Vázquez de Espinosa. Transcrito del manuscrito original por Charles Upson Clark. (Smithsonian Miscellaneous Collections, Vol. 108: Publication 3898.) Pp. xii+801. (Washington, D.C.: Smithsonian Institution, 1948.) n.p.

THIS thick volume is a transcription of an unidentified manuscript found in the Vatican by Mr. C. U. Clark in 1930 and afterwards ascribed without any doubt to the Carmelite Fray Antonio Vázquez de Espinosa. Mr. Clark edited it and translated it into English, and this version appeared in 1942 as vol. 102 of the Smithsonian Miscellaneous Collections. It proved impossible to carry out the editor's original intention of publishing the Spanish text opposite the translation, and its appearance six years later cannot but be somewhat of an anti-climax to English readers. The work itself is a description, mainly geographical in the widest sense, of Central and South America and the Philippines, and it includes matter for the anthropologist, the botanist and the historian; however, the author does not claim special historical knowledge—in fact his remarks about the Inca Atahuallpa show less of knowledge than a desire to vindicate his countrymen. The editor considers that the greatest value of the work lies in the picture it gives of contemporary Spanish colonial and ecclesiastical administration at a period which is not adequately covered by other writers.

The book was written in 1628, and internal evidence shows that Vázquez's travels lasted over at least the years 1612–21. He gathered much of the information himself, covering a surprising amount of country in lands where travel has always been difficult and full of hardship. He was at pains to learn from eye-witnesses about regions which he could not visit, and his information, though necessarily variable in the amount of detail given, rings true in the ears of a modern traveller who knows a few of the places he describes.

G. H. S. BUSHNELL

Some Notes on the Psychology of Pierre Janet

By Elton Mayo. Pp. ix+132. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 14*s*. net.

IN his researches into human problems in industry, Prof. Elton Mayo has been considerably influenced by the work of Pierre Janet, the French psychologist. Janet's findings have been less well known in the English-speaking countries than on the Continent, since few of his important works have been translated into English. To help those who wish to read Janet in the original French as an aid to their studies of society or of industry, Mayo has brought together some notes which were originally prepared for his colleagues at the Harvard Graduate School of Business Administration whose work demanded close attention to the difficult individual, social and administrative problems of our time. For many years Janet's clinical contributions to psychopathology have been dismissed somewhat cavalierly as something which has been superseded by Freudian and other developments. Readers of these notes will find that there is little real conflict between the observations of Janet and Freud, and that Janet's investigations into the restricted field of obsessive thinking are in many ways mutually complementary to Freud's more widely ranging hypotheses. The book, written with Mayo's usual enthusiasm and sincerity, also includes his address to the Harvard Medical School on "Frightened People", in which he describes the causes of fear in individuals and the need for effective re-assurance in the consulting room.

T. H. H.

Proteins and Amino Acids in Nutrition

Edited by Dr. Melville Sahyun. Pp. xvi + 566. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1948.) 45*s*. net.

THIS collection of articles, by various experts, some of them having the standing of international authorities, covers a wider field than one could infer from its title. It is a long way from the feeding of pregnant women to the size of particles found in rabbit papillomas. The only connexion is that both have a *p* in them, the *p* standing for protein. This is essentially a book for libraries and is in some ways an essential book for libraries; many who cannot be expected to pay its rather high price for very occasional use will want to consult it from time to time, until the day when, like all such compilations, it has become too out-of-date to have anything but historical value. This will be small, for it bears no impress of individual personality or even of editorial policy; it is rather a friendly symposium, at a high technical level, unhampered by fear of the chairman's gavel. Names such as H. H. Mitchell, Lela Booher, H. J. Almquist, Clarence Berg and the editor himself guarantee, however, that the contributions to the symposium will—etymology notwithstanding—be full of meat. From the British reader's point of view, however, the 94 pages of appendix are almost complete waste of space.

A. L. B.

PIERRE SIMON LAPLACE (1749–1827)

By Dr. S. LILLEY
St. John's College, Cambridge

DESPITE the immensity of his achievement, Newton had scarcely done more than pose the problem of explaining the observed behaviour of the solar system in terms of his laws of motion and the inverse square law of gravitation. Until the full complexities of the observed behaviour of the planets and their satellites had been shown to be deducible from the Newtonian laws, philosophers might (and sometimes did) doubt whether gravitation alone was a sufficient principle of explanation in celestial mechanics. The task of completing the Newtonian celestial mechanics was largely carried out in the century after Newton's death by French mathematicians, and above all by Laplace.

Of Laplace's great book, Grant remarked, "The physical theory of the planetary system is exhibited in the *Mécanique Céleste* in a state of almost complete development"[1]. There were details to be filled in, of course—even some that required prodigious efforts of thought and calculation, like the explanation of Saturn's vagaries by the prediction of Adams and Leverrier in 1845–46 that they were caused by a yet undiscovered planet, Neptune. There were mistakes to be corrected—a fortuitous coincidence with observation, which Laplace had obtained by neglecting non-negligible quantities in his explanation (1787) of the moon's secular acceleration in terms of the changing ellipticity of the earth's orbit, was only pointed out by Adams in 1853. But by and large, Grant's assessment is correct, provided we substitute the word 'Newtonian' for 'physical' in the sentence quoted; for the main nineteenth-century advances were made by taking into account physical phenomena —such as tidal friction—not contemplated in a purely Newtonian scheme. It was by tidal friction that the error regarding the moon's secular acceleration, for example, was eventually cleared up by Delaunay.

Pierre Simon Laplace was born of a Normandy peasant family on or about March 23, 1749, and died on March 5, 1827. There is sufficient of a seamy side in his personal and political life (for, like many French scientific men of his times, he took part in politics during and after the Revolution) to make it advisable in a short note to give no more of his biographical details.

The scope of Laplace's astronomical work makes it impossible to do more than mention some of his contributions. With Lagrange, he accounted for most of the outstanding planetary inequalities. His improvements in the lunar theory were immense—particularly the entirely new mode of treatment which he introduced in the third volume of the "Mécanique Céleste". Even his only partially correct explanation of the moon's secular acceleration was a great achievement, since the problem had baffled others so completely that Lagrange, for example, had been led to doubt the observations. He took a first step towards Maxwell's elucidation of the structure of Saturn's rings when he showed that they could not be uniform solid bodies. He introduced a dynamical theory of the tides, an enormous advance on the statical theories that had preceded it, though still inadequate to describe the physical realities of tides on so complicated a surface as that of the earth.

But Laplace's most impressive achievement was the series of researches, conducted in competitive co-operation with Lagrange, that led to the demonstration of the stability of the solar system. Beginning in 1773, these researches passed through such steps as the explanation of the inequalities of Saturn and Jupiter, to the two following remarkable propositions:

(1) Take for each planet the product,

$$\text{mass} \times \sqrt{\text{axis of orbit}} \times (\text{eccentricity})^2.$$

The sum of these products over all planets is invariable.

(2) The proposition obtained from (1) by substituting the tangent of the inclination of the planet's orbit for its eccentricity is likewise true.

In each case the truth of the proposition depends on the fact that all the planets revolve in the same direction around the sun. Since both these quantities are known to be small at the present epoch, it follows that, under Newtonian assumptions, the eccentricities and inclinations must always remain small. In other words, the solar system will continue indefinitely in something closely approaching its present form.

In his "Mécanique Céleste" (1799, 1802, 1805, 1825), Laplace gave an exposition of all existing knowledge of physical astronomy. The book exhibits the solar system as a vast and complex machine, every movement of which is a mere working out of the laws of mechanics and gravitation, while its continued functioning for an indefinite period is guaranteed by the two propositions on stability referred to above. Napoleon, according to a favourite story, remarked to Laplace that God was nowhere mentioned in his work; and Laplace replied, "Je n'avais besoin de cette hypothèse-là". It was this aspect of Laplace's work that most struck his contemporaries. An age that was still dominated by natural theology could not but be shocked at the idea of a universe so perfectly mechanical as not to require Providential intervention to ensure its continued working, or at least special planning by the Creator at the time of creation to ensure that the machine would work indefinitely. Astronomical treatises of the time, and especially popular and semi-popular presentations in encyclopædias and the like[2], devote much space to showing that Laplace has not abolished the 'argument from design'—the fact that the demonstration of stability depends on the rotation of the planets all in one direction is taken as an argument that they must have been designed to do so; the inverse square law is somewhat heatedly asserted to be a matter of Providential design and not, as Laplace and others would have it, an essential attribute of central forces; and so on.

This opposition emphasizes one of Laplace's more general contributions to thought: his enormous astronomical achievements were among the most important of the factors which slowly drove teleology out of science during the course of the nineteenth century. (On the negative side, the success of celestial mechanics must bear a share of the blame for the extreme mechanistic attitude that permeated later nineteenth-century physics.)

Another contribution to this wider sphere of thought came from Laplace's nebular hypothesis for

the origin of the solar system, which he propounded only half seriously in his "Système du Monde" (1796). Inadequate to explain the actual facts, it nevertheless helped to establish the conception of a universe which evolves historically through long periods of time, in place of the static, unhistorical world-view that had hitherto dominated European thought, with its correlative belief that the world was only a few thousand years old. The nebular hypothesis took its place along with the first significant attempts at evolutionary theories in geology (Hutton, 1785) and in biology (Erasmus Darwin, 1794, and Lamarck, 1801) in making the first breaches in this unhistorical universe. (The almost simultaneous appearance of these three theories is probably not entirely independent of the ideas about social evolution that became common before and during the French Revolution.)

Laplace did little in experimental science. He did, however, collaborate with Lavoisier in researches (published in 1784) which rank second only to those of Joseph Black in the foundation of calorimetry, and which led to the first clear conceptions of the relations between combustion and respiration.

On the other hand, he played an important part in the first stages of the development of mathematical physics (as contrasted with mechanics), which was to burst forth in full vigour with the work of men like Fourier, Poisson and Fresnel a few years later. Some of the beginnings of this new movement can be traced to Laplace's theory of capillarity (1805, independently developed by Thomas Young about the same time), his correction of Newton's formula for the velocity of sound (by making allowance for adiabatic compression and expansion), and his less fortunate attempts to give satisfactory mathematical formulations to the corpuscular theory of light and the imponderable fluid theory of heat.

It is the common fate of great men that their more concrete scientific contributions soon find their way into the attic store-room of 'mere history', because they are quickly superseded; while their more abstract methodological contributions may survive for centuries as the working tools of future generations. Laplace's not negligible work in such practical matters as navigational astronomy had only a short-term significance and is now almost forgotten (though the metric system constantly reminds us of another practical matter in which he took part). Much of his astronomy has also now become mere history: what, for example, can be the significance of his demonstration that the abstract universe with which he dealt is stable, when we know that the physical universe includes important phenomena like tidal friction which his work ignored? But some of the mathematical tools which Laplace invented or developed in the course of his researches came to be among the everyday working tools of mathematical physicists, and remain so to-day.

Laplace had almost no interest in mathematics as such. It was to him just a tool for solving physical problems. Hence his mathematical style was far from elegant, and often very obscure. It is, furthermore, difficult to distinguish precisely his own mathematical discoveries, since he borrowed unashamedly without acknowledgment. The concept of potential he got from Lagrange, and even the famous 'Laplace's equation', $\nabla^2 V = 0$, where V is the potential, occurs in hydrodynamical researches by Lagrange so early as 1760. But it was Laplace's use of these tools in gravitational problems that demonstrated their power, so that the attaching of his name to that now ubiquitous equation is perfectly justified. He also made notable contributions to the special functions occurring in boundary-value problems. In fact, many of the partial differential equations that became important in the nineteenth century and much of the mathematics of boundary-value problems arise directly or indirectly from Laplace's work. From the potential theory one can trace, for example, a connexion to Riemann's special approach to the theory of functions of a complex variable, and thence to one of the sources for the development of topology. In similar ways one could, if the search were worth the trouble, find part of the sources of much nineteenth-century mathematics (which the twentieth century still uses) in the work of Laplace. Another mathematical tool still in everyday use is Laplace's rule for the expansion of a determinant, which he gave in a clumsy form in 1772.

Laplace's work on the theory of probability was again derivative in the first place from his astronomical work; but in this case he did go on to develop it for its own sake ("Théorie Analytique des Probabilités", 1812). This is usually considered as the greatest contribution by any one man to probability theory. Laplace had earlier discovered the normal error law. But his most important advance is his consistent and extensive use of continuous probability distributions, which had made only rare and sporadic appearances with previous writers. It is this point especially that entitles his book to be called the first presentation of something like a modern theory of probability in connected form.

[1] Grant, Robert, "History of Physical Astronomy", 106 (London, 1852).
[2] For example, "Pantalogia, A New Cyclopædia" (London, 1813), article "Astronomy", cols. 13–14. I merely cite an example which happens to be on my shelves at the moment of writing.

SCIENCE AND DEVELOPMENT IN THE PACIFIC AREA

By Sir NORMAN HAWORTH, F.R.S.

THE Seventh Pacific Science Congress met at Auckland and Christchurch, New Zealand, during February 2–22, under the auspices of the Royal Society of New Zealand and its president, Dr. R. A. Falla, who presided over the Congress. The secretary-general was Dr. Gilbert Archey, director of the Auckland Museum, and Prof. R. S. Allan was chairman of the Christchurch committee. The New Zealand Government extended invitations to forty-eight countries represented in the Pacific Science Association, to the South Pacific Commission and Health Service and the specialized agencies of the United Nations and the Economic Commission for Asia and the Far East. About 220 delegates attended from overseas, and some 150 from New Zealand. Earlier Congresses have been held in Hawaii (1920), Australia (1923), Japan (1926), Java (1929), British Columbia (1933), California (1939). Their purpose has been to initiate discussions on scientific topics of special significance to the Pacific area and of importance to the welfare of its peoples. Sessions of the present Congress were devoted to discussions of major problems, particularly those demanding close co-operation between sciences and between countries, and the formulation of further research plans required to secure these aims.

In the Geology, Vulcanology and Geophysics Section, a remarkable colour-film was shown of the birth and development of a new volcano rising from the agricultural plain at Paricutin in Mexico. In a few months this volcano, amid its fringe of hot flowing lava and dust, attained a height of 1,400 ft. above the plain and submerged a village. Beno Gutenberg, of the Seismological Laboratory at Pasadena, presented a map showing the Pacific basin surrounded by volcanic and seismic activity. A systematic relationship was found between the distribution of the gravity field, deep sea trenches, island areas, and foci of earthquakes. One session was devoted to recent work on cosmic noise. E. G. Bowen gave an account of radio noise coming from the region around the sun, and suggested that the temperature of this region rises rapidly with increasing distance from the sun.

Weather forecasting in the tropics and the mechanism of typhoons were the subjects of several papers in the Meteorology Section. If a sufficient number of tropical weather stations were available, one of the most fruitful methods of forecasting would be to measure the convergence of surface winds with the view of finding where the air was rising. Major W. S. Barney, of the U.S. Air Force, described how, during a recent typhoon which swept over the Philippines, weather reconnaissance squadrons determined its centre from day to day during December 2–10, 1948. They found that at 10,000 ft. they were above the violent part of the storm. In the centre was a calm circular area some twenty miles in diameter in which the sky was clear. Descending into this area to 1,500 ft. they saw the clouds in the form of a vertical wall around them. They flew into this cylindrical wall and encountered such violent up-currents and turbulence that their aircraft was damaged despite its great strength. The physical features which determine the course of tropical cyclones were discussed. From an analysis of upper air data, R. H. Simpson, of the U.S. Weather Service, suggested that at some 15,000 ft. the isotherms are circular except for a tongue of warm air which projects in the direction towards which the storm is moving.

On the general circulation of the atmosphere, C. H. B. Priestly described how upper air data can be used to calculate the flow of heat and momentum over the whole of a parallel of latitude. The difference between the amounts flowing over two such circles of latitude was accounted for by absorption at the earth's surface in the area between them. Sir Geoffrey Taylor contributed a paper on convection currents in the atmosphere over a source of heat. He showed how laboratory experiments with a small source of heat like a Bunsen burner may be used to explain and describe the upward currents of air over a volcano or a forest fire. Instrumental techniques were described in several papers, which included an account of the upper air stations in the Canadian Arctic, the use of a balloon-borne instrument for measuring potential gradient, and the operation of meteorological balloons so controlled that they remain in given limits of height. E. G. Bowen described the artificial production of rain. The temperature of a cloud was first determined, and it was then seeded with 'dry ice' from an aircraft at frequent intervals. In most cases rain was produced when the temperature of the cloud was below the freezing point; but never when the temperature was above it.

In the Oceanography Section papers were presented in all aspects of the subject: geological, physical, chemical and biological. Among the geological studies an important feature was the abundance of new data from the survey of the U.S. Navy in the Pacific Ocean and of the Bikini Atoll. F. P. Shepard, of the Scripps Institution, reported the results of further exploration of deep-sea canyons. On the physical side it has become clear that one of the main objects of applied oceanography is to obtain a complete picture of the distribution of water of different physical and chemical properties and of the water movements. Since this is unlikely to be achieved by survey work alone, attention is being given to the fundamental processes by which radiation, wind, turbulent flow, and like factors affect the distribution and produce seasonal and other changes. Such new knowledge is imperatively needed, and its interest should attract to oceanography able mathematicians and physicists in the same way that marine biology has attracted zoologists. One such physicist, G. E. R. Deacon, was warmly appreciated for the lead he gave in a variety of problems when he described the Discovery Committee's work on surface boundaries in the South Pacific Ocean and also the researches of the Royal Naval Scientific Service on waves, microseisms and the electrical and magnetic effects of water movements and earth currents in the sea. The latter investigation revived earlier attempts by Faraday to apply this principle to the measurement of marine currents, and its success now places a new instrument in the hands of future observers. N. A. Mackintosh, the director of research of the Discovery Committee, communicated a paper on the distribution of whales in the South Pacific. Martin W. Johnson, of California, played recordings of sounds made by fish against the continual sound of the sea. The crackling sound made by the snapping shrimp, heard also through the hulls of yachts, resembled the sound of boring, or the noise of a busy factory. There were low grunts from sea-robins, while other fish made sounds like the chirping call of a bird, the mewing of a kitten, and the whirring sound of a propeller. Most spectacular were the sounds from porpoises, ranging from noises like the barking of dogs to the tuning-in whistles of a radio set. Long series of great hic-coughing noises were probably from humpback whales. Prof. C. M. Yonge, of Glasgow, gave a public lecture on the reef-building corals.

The Zoology Section covered a wide field; but the central theme was the consideration of the terrestrial, freshwater and marine faunas of the Pacific. Contacts with agriculture were made through economic entomology, and with oceanography by way of fish and fisheries and by joint discussions with these two related sections of the Congress. These talks led to a symposium on the protection of Nature in the Pacific and on the prospect of a world approach to international conservation.

There appeared to be two aspects of this latter problem. First there is the need for careful conservation in the Pacific area of the terrestrial and marine resources of raw materials and food for rapidly increasing human populations in the region. Fisheries have not yet been fully exploited, and interest centred around an American project to spend a million dollars on a survey of the marine resources and especially the tuna fisheries around Hawaii. The population of the Philippines depends almost wholly on rice and fish, and only an increased

supply of the latter seems feasible as the immediate answer to the urgent problem of a rapidly rising human population.

The second aspect of conservation is the need to rescue and preserve agriculture from the ill-effects on native fauna and flora of introduced animals and plants. In the Hawaiian Islands, there are species of plants now confined to single areas and reduced to a few individuals. In New Zealand, also, innumerable problems have been created by the introduction of many species of plants and animals. Quite apart from the doubtful expedient of the original British settlers of firing large areas of bush country as a means of clearance, widespread erosion has been caused by the destruction of mountain flora by deer, and the damage caused by opossums, goats, hedgehogs and rabbits is no less serious. No region in the world has suffered more from the effects of man's interference with Nature than the islands of the Pacific, including Australia and New Zealand. The Congress made detailed reference to these many problems and their remedies. The extermination in 1946 of the goats on the now uninhabited Three Kings Islands off the northern tip of New Zealand has resulted in the regeneration of the flora; the Islands were rapidly approaching the degree of bareness and aridity experienced in St. Helena more than a century ago. Valuable reports were presented by E. Mayr on the terrestrial faunas of the Pacific, including a survey of geological structure and geological history and their biological implications.

Distribution and utilization of marine Algæ received attention in the Botany Section. Distribution was considered to be more satisfactorily explained on the basis of continental drift than on the land-bridge hypothesis. Plant geography in the Pacific area was discussed, and attention was directed to O. H. Selling's publications on pollen studies of living Hawaiian plants and related genera elsewhere. Associated studies of the late Quaternary history of vegetation give striking indications of climatic waves in the recent history of these islands. C. Skottsberg discussed the flora of Hawaii and stressed the continental character rather than the insular, its strongest affinities being in the southerly Pacific area. Some results of recent research by the Swedish Deep Sea Expedition, and their bearing on the stability of the Pacific Ocean, were reported by H. Pettersson. H. J. Lam, of Leyden, outlined the progress of compilation of distribution maps of Pacific plant taxa. R. A. Silow, representing the Genetical Society of Great Britain, spoke on the problems of trans-Pacific migration involved in the origin of the New World cottons, and the suggestion of recent prehistoric influence from southern Asia in South America.

The section devoted to Soil Resources, Forestry and Agriculture took in a wide survey. The future of the Pacific countries depends largely on the right use of land resources. Methods of soil survey were compared, and differences were found to exist rather in nomenclature than in the actual nature of the categories. It is important to understand the genetic relationship of the soils mapped; discussions revealed a satisfactory overall agreement in aims and methods. Greater divergences appeared on the subject of land classification, where the objective is to integrate the physical, economic and other factors into a system which prescribes 'land-use capabilities'. Here the ascertainable facts are combined with personal judgment and have not the scientific accuracy of soil classifications, although examples of such land classification which had been proved accurate by experience were given. To many, 'land-use capability' is governed by erosion potential, which is a menace to be guarded against in all future land development.

In all this, forestry policy has an important place, and much time was devoted to problems affecting forestry in the Pacific area. Of exotic species tried in New Zealand, *Pinus radiata* was found to have been eminently satisfactory. Changes taking place in the general rural economy of the North Island were described by N. H. Taylor, of the Soil Bureau, Department of Scientific and Industrial Research, Wellington. This account was followed by an extensive tour in which the relation between soil, climate and the development of different systems of agricultural and forestry policy and production was clearly demonstrated. Large areas of North Island are covered by soils of fairly recent volcanic origin. The original forest was burnt off by early settlers to provide grazing lands. Lime and phosphate are the chief deficiencies where grass and clover are to be grown for intensive dairying. Despite such fertilizer treatment, scores of thousands of acres were of limited value for livestock farming owing to the intractable 'bush sickness'; but this has now been remedied by the application of cobalt salts. R. W. Phillips and C. P. Meekan opened discussions on dairy cattle improvement, and these led to lively comments. Such questions are receiving much less attention than they deserve in the Pacific countries. The outstanding developments of the Jersey for butter-fat production and of the Corriedale and other breeds for wool and fat-lamb production were, however, seen at first hand, as was also a Dutch Friesian herd of cattle with a butter-fat yield of well over four per cent.

Anthropology, Public Health and Nutrition, and Social Sciences were represented in three further sections of the Congress which often met in joint session. Sir Peter Buck, now director of the Bernice P. Bishop Museum at Honolulu, was a dominant figure; he was a medical graduate of Otago University at Dunedin, where most of his work has been done. His lectures and researches in anthropology, his book on the "Vikings of the Sunrise", and his part-Maori ancestry combined to make him the acclaimed, though modest, leader before popular audiences. V. W. T. McGusty, formerly director of medical services in Fiji, outlined the Colonial policy of administration in which primitive forms of society are protected and native medical officers are employed for the control of disease. Sir Peter Buck said this example is being followed by the United States in its trust territories in the Pacific. Similar training schools have been established at Guam which will provide native medical workers for the rest of Micronesia. E. Beaglehole, of Wellington, said that Colonial Powers are prone to believe that backward races require the same type of government as their own complex societies, whereas the islanders had a workable self-government before Europeans came, and would develop new procedures in their simple communities as their needs expanded. A. P. Elkin, of Sydney, said it has been proved that the aborigine in Australia can be led to an intelligent appreciation of the intruder's culture if his right to participate in citizenship is recognized. The report of the committee on blood groups of the Pacific area was given by H. L. Shapiro, of New York, and he also, along with

G. P. Murdoch, of Yale, outlined the anthropological studies in Micronesia. Papers on dental caries, tuberculosis and tropical diseases, together with reports on remedial measures, were contributed, and further research programmes were discussed. These sessions covered a wide and important field on medical and social problems, and represented a very live and vigorous section of the Congress. The present writer presided at a general Congress discussion on the "Social Implications of Science".

Parties of overseas delegates in groups of some twenty members were taken on conducted tours each of a week's duration through the North and South Islands. These tours were arranged to bring delegates south from Auckland to Christchurch with stops at interesting centres *en route*, and also after the termination of the Christchurch sessions. Apart from the scenic interest of these excursions by road, the delegates gained, by scientific intercourse and social fellowship, a lasting benefit comparable with, or even exceeding, that of the organised Congress itself.

In conclusion, it is a pleasant duty to acknowledge the help I have received from my fellow delegates from Britain in compiling this report, namely, Prof. G. W. Robinson, the leader; Sir Geoffrey Taylor; Prof. H. D. Kay; Prof. C. M. Yonge; Dr. G. E. R. Deacon and Dr. R. A. Silow, whose impressions, together with my own, I have endeavoured to record. These can, however, reflect only a small part of the whole work of the Congress.

PRE-STRESSED CONCRETE

IN recent years there has been a growing interest among engineers in the use of pre-stressing for concrete structures, and on February 16 a conference was held at the Institution of Civil Engineers to review the present position of pre-stressed concrete. The conference was arranged under the auspices of the Institution and the Joint Committee on Materials and their Testing (a Committee representing some twenty-five technical and professional institutions and societies). The chair was taken, for the morning session, by Mr. R. H. H. Stanger, and, for the afternoon session, by Mr. W. K. Wallace.

A paper by Dr. F. G. Thomas, of the Building Research Station, had been prepared as a basis for discussion. The basic principle of pre-stressing, Dr. Thomas pointed out, consists in the imposition of preliminary internal stresses in a structure before the working loads are applied, in such a way as to lead to a more favourable state of stress when these loads come into action. The preliminary stresses induced in concrete are essentially pre-compressions, which may be uniform or non-uniform, with the primary object of avoiding cracking under the conditions of working load. In most practical cases the pre-stress is applied by stretched steel wires of high tensile strength.

A description of the early development of the technique was followed in the paper by a comprehensive survey of the basic features of pre-stressed concrete, including the materials used, the fundamental assumptions to be made in design and the various practical systems of pre-stressing. Dr. Thomas gave a brief account of the experimental investigations that have been made, and concluded with descriptions of constructional work executed in Great Britain and elsewhere. This section of the paper embraced references to bridges, tanks, reservoirs and pipes, buildings, and miscellaneous work such as tunnels, harbour construction, aeroplane runways and railway sleepers.

In introducing his paper, Dr. Thomas emphasized the need for high-quality materials to be used in pre-stressed concrete construction. Although a high strength of concrete is not always necessary, but often desirable, a high standard of quality control is essential. A high early strength of the concrete is required on economic grounds, and usually a rapid-hardening cement is adopted or suitable accelerators are incorporated in the concrete mix; curing with steam or electric heating is also of value in regard to rapidity of hardening.

For most of the design calculations, Dr. Thomas pointed out, no new theory is necessary. The classic theory of elasticity is applicable if approximate allowances are made for the effects of inelastic deformations due to creep (of steel and concrete) and to shrinkage of the concrete. There are two main systems of pre-stressing: the pre-tensioning system, in which the wires are stretched before the concrete has set; and the post-tensioning system, in which the wires are stretched after the concrete has hardened and obtained considerable strength. Whatever basic system of pre-stressing is adopted, there are many variations in the actual detailed arrangements. A study of the relative merits of the main processes has led Dr. Thomas to the conclusion that there is no general technical justification for one rather than another; the method to be chosen appears to depend upon technical and economic considerations relating to the particular circumstances of each design.

Referring to constructional work already completed, Dr. Thomas observed that the main advantages of pre-stressing have been obtained in beams and fluid-retaining structures. In the case of beams, the greatest advantages are reached where the effects of reduced sections and light weight are particularly important, that is, in bridges of larger span. In the case of fluid-retaining structures, where cracking must be avoided and where difficulty has been experienced in obtaining satisfactory joints in ordinary reinforced concrete, it seems certain that in the future a greater proportion of these structures will be made of pre-stressed concrete.

The possibility of using pre-stressing for roads or runways is of interest, particularly in view of the difficulty experienced in the past in obtaining good joints. In the Orly Airport runway, Freyssinet has experimented in this direction, and it may well be that pre-stressing will solve another difficult civil-engineering problem.

In the discussion which followed the presentation of the introductory paper, several speakers emphasized the desirability of using high-grade materials. Mr. J. W. H. King (Queen Mary College, London) pointed out that metallurgical study shows that the hard-drawn wire commonly used for pre-stressing possesses certain properties as a result of the drawing process in manufacture (for example, creep under sustained load or deformation) which are detrimental to the efficiency of the wire as a pre-stressing agent, subject to high tensile stress for the whole life of the structure. Prof. R. H. Evans (University of Leeds) agreed with Dr. Thomas that with 0·2-in. diameter wire the margin of safety against wire slip, in systems dependent on the bond between concrete and steel, is often not sufficient. Tests at the University of Leeds

have shown that, for the transfer of the pre-stressing load from the steel to concrete by surface interaction alone, a length of wire of 80–250 diameters is necessary. Triple-stranded wires have been found to have better bond characteristics than single round wires. Mr. U. Bjuggren (Stockholm) remarked that in Sweden small-diameter (0·08-in.) wires are used in pre-tensioning systems; up to 140 wires have been used in a relatively small cross-section, and satisfactory bond has been obtained.

In regard to the concrete quality, Dr. A. R. Collins (Cement and Concrete Association) spoke of the simplicity of the arrangement of steel in pre-stressed concrete, contrasting this with the conglomeration of reinforcement in ordinary reinforced concrete. The simplicity is coupled with a greatly reduced amount of steel and allows the use of a concrete of relatively low workability and high durability. Concrete of high strength is not difficult to obtain if adequate control is exercised in the measurement and proportioning of the materials, and if the water content is limited to the minimum necessary for proper compaction of the concrete.

Mr. R. S. V. Barber (Dow-Mac (Products), Ltd.) and Mr. J. Ludlow (Metropolitan-Vickers Electrical Co., Ltd.) described work on electric heating as a method of accelerating the hardening of concrete, pointing out that electric heating can be arranged with the electric current passing through the concrete or alternatively through the reinforcing wires. The former has been used as a conductor, particularly in the U.S.S.R., to avoid frost action during the early hardening of the concrete, but a high current-density may affect the proper hydration of the cement. Mr. Barber and Mr. Ludlow said that they have therefore used the alternative method, namely, of heating the embedded wires, in the production of concrete railway-sleepers. This method has the advantages that the electrical resistance of the steel is constant, stable and small. The arrangement of straight wires in the pre-tensioning system is ideal for this treatment, which has resulted in a reduction in the production cycle from five to one day or even less.

On the fundamental approach to the design of pre-stressed concrete members there was some divergence of opinion. Prof. A. L. L. Baker (University of London) presented an analytical method for the determination of the ultimate strength of a pre-stressed concrete beam, and Prof. A. D. Ross (University of London) discussed the accurate assessment of losses of pre-stress due to inelastic deformation of the concrete. Other speakers were in favour of simple approximations for these losses; and Mr. Bjuggren (Stockholm) relied for his designs on empirical rules based on hundreds of tests.

The application of pre-stressed concrete to various structural systems was discussed by several speakers. Major A. J. Harris (Société Technique pour l'Utilisation de la Précontrainte, Paris), representing M. E. Freyssinet, showed how the difficulties of obtaining structurally continuous systems have been overcome in France. In statically indeterminate systems, pre-stressing tends to modify the supporting reactions for beams, involving an elaboration of the design calculations, and it also introduces practical difficulties. M. Freyssinet has devised a system of beams of variable cross-section, pre-stressed by straight cables, which has largely obviated the difficulties. In an alternative solution, the reactions are adjusted in practice to the values assumed in design, by introducing special small flat jacks. Major Harris also described the construction of bridges from pre-fabricated units. Elements 6 ft. long, cast in a factory, are later assembled to form a 240-ft. span bridge, the elements being held together by pre-stressing cables.

Mr. N. W. Swinnerton (British Railways) described the development of pre-stressed concrete railway-sleepers in Great Britain, involving laboratory tests and trials in high-speed track, leading to two designs which show promise. Mr. J. S. Campbell and Dr. P. W. Abeles (British Railways) spoke of successful bridge construction already completed in Great Britain and of further work soon to be started. In this latter connexion, Dr. Abeles discussed designs in which pre-stressed units would be combined with *in situ* concrete without preliminary stress, and gave details of tests showing that such composite construction is practicable and amenable to accurate stress analysis.

Mr. L. W. Elliott put forward the architect's point of view on pre-stressed concrete. The three essential considerations are the æsthetic, the functional and the economic aspects. The practical examples have shown that æsthetic and functional requirements can be well satisfied, and it appears that this type of construction is also economical. Mr. D. H. May (Stressed Concrete Design, Ltd.) discussed the economical aspect further, and gave evidence of cases in which pre-stressed concrete has been chosen, in direct competition with steel and reinforced concrete, for several structures in Europe and in America.

The proceedings of the conference are to be published later this year.

NEW FELLOWS OF THE ROYAL SOCIETY

AT the meeting of the Royal Society on March 17, the following were elected to fellowship:

Prof. J. F. Allen, professor of natural philosophy, University of St. Andrews, distinguished for his work in low-temperature physics, especially for his discovery of new phenomena shown by liquid helium.

R. W. Bailey, head of the Mechanical and Metallurgical Research Department at Metropolitan-Vickers, Manchester, distinguished for contributions on the behaviour of metals at high temperatures and for advances in design of turbines.

Dr. F. C. Bawden, head of the Plant Pathology Department at Rothamsted Experimental Station, Harpenden, distinguished for his work on plant viruses and virus diseases, and for important contributions to the study of virus serology.

Prof. F. W. Rogers Brambell, Lloyd Roberts professor of zoology, University College of North Wales, Bangor, distinguished for his experimental studies of processes of reproduction in mammals and of the factors concerned in antenatal mortality.

Prof. K. E. Bullen, professor of applied mathematics in the University of Sydney, distinguished for work in geophysics, particularly in relation to earthquakes and the distribution of density within the earth.

Dr. E. B. Chain, university demonstrator in chemical pathology, University of Oxford, distinguished for his work on enzymes of snake-venom and bacteria, and especially for his researches on penicillin and other antibiotics.

Dr. U. R. Evans, reader in metallic corrosion, University of Cambridge, distinguished for his researches on metallic corrosion.

Prof. E. D. Hughes, professor of chemistry, University College, London, distinguished for his researches in the mechanism of the reactions of carbon compounds.

Prof. W. Q. Kennedy, professor of geology, University of Leeds, distinguished for his contributions to tectonic geology and petrogenesis.

Prof. W. B. R. King, Woodwardian professor of geology, University of Cambridge, distinguished for his researches on the Lower Palæozoic rocks and on Pleistocene deposits.

Sir Ben Lockspeiser, chief scientist, Ministry of Supply, distinguished for his contributions to the development of modern aircraft.

Dr. J. M. McNeill, naval architect, John Brown and Co., Ltd., Clydebank, distinguished for his contributions to naval architecture.

Dr. H. R. Marston, chief of the Division of Biochemistry and General Nutrition, Commonwealth Council for Scientific and Industrial Research (University of Adelaide, South Australia), distinguished for his researches on nutrition and wool-growth in merino sheep and on trace element-deficiency diseases in ruminants.

Prof. K. Mather, professor of genetics, University of Birmingham, distinguished for his contributions to genetics and particularly for his studies of polygenic inheritance.

Prof. P. B. Medawar, Mason professor of zoology and comparative anatomy, University of Birmingham, distinguished for his studies of growth processes and the phenomena associated with tissue transplantation

Dr. W. T. J. Morgan, research worker, Lister Institute of Preventive Medicine and reader in biochemistry in the University of London, distinguished for his contributions to the chemistry of immunology and blood groups.

N. W. Pirie, head of the Biochemical Department, Rothamsted Experimental Station, Harpenden, distinguished for his researches on the chemical and physical properties of plant viruses.

Prof. C. F. Powell, Melville Wills professor of physics, University of Bristol, distinguished for his contributions to experimental physics, especially for his work on the properties of mesons.

Dr. D. A. Scott, research member, Connaught Laboratories, University of Toronto, distinguished for his contributions to the chemistry of insulin, heparin and carbonic anhydrase.

Prof. Wilson Smith, professor of bacteriology, University College Hospital Medical School, London, distinguished for his researches on the virus of influenza and on the pathology of staphylococcal infections.

Dr. G. B. B. M. Sutherland, reader in spectroscopy, Department of Colloid Science, University of Cambridge, distinguished for his experimental researches on infra-red and Raman spectroscopy, especially of hydrocarbons.

Prof. O. G. Sutton, professor of mathematics and physics, Military College of Science, Shrivenham, distinguished for his researches in atmospheric turbulence and evaporation.

Prof. Meirion Thomas, professor of botany at King's College, Newcastle-upon-Tyne, distinguished for his researches in plant physiology, and particularly for his work on the breakdown of sugar in the plant.

Prof. J. M. Whittaker, professor of mathematics, University of Liverpool, distinguished for his researches in the theory of integral functions.

Prof. F. G. Young, professor of biochemistry, University College, London, distinguished for his studies of the role of the hormones of the anterior lobe of the pituitary gland in carbohydrate metabolism.

NEWS and VIEWS

King's College, London: Prof. W. T. Gordon

Prof. W. T. Gordon retires at the end of the present session from the chair of geology, King's College, London. He joined the staff of the College as lecturer in charge of the then quite small Department of Geology in 1914. In 1921 he became professor of geology, a post held in the earlier days of the College by Charles Lyell, John Phillips, D. T. Ansted, James Tennant and Martin Duncan. It fell to Gordon to organise the expansion of the Department and its work which followed the First World War, and he also served as administrative head of the Department of Geography conducted jointly with the London School of Economics. Throughout his long years of service, Prof. Gordon has been a well-known and well-loved figure in his College and his University, taking a large part in the life and work of both. At the same time he has continued to prosecute his researches into the Scottish Lower Carboniferous flora, begun as a young man in Edinburgh. Not the least of his great services to his College arose from his abiding interest in mineralogy: the Department possesses by virtue of his efforts an unusually fine collection of well-crystallized minerals, and his own collection of gem stones has become justly famous to a long succession of students.

Dr. J. H. Taylor

Dr. J. H. Taylor, who succeeds Prof. Gordon as professor of geology at King's College, London, in September, was educated at Clifton College, Bristol, and was an undergraduate at King's College. As such, he distinguished himself in every field, in scholarship, athletics and general service to the College. He obtained first-class honours in geology at the Final Examinations of the University of London, and, as the most distinguished man of his year in science at King's College, he was awarded the Jelf Medal, the most prized distinction to which a student can aspire. After a year's service on the staff of the Geological Department at King's College, he was elected to a Henry Fellowship at Harvard University, and while there he obtained the degree of A.M. Returning to Britain to join the Geological Survey of Great Britain, he continued his petrological researches into the rocks of the East Midlands, and particularly the sedimentary iron ores and associated rocks of Northamptonshire and Leicestershire. He was, consequently, selected as a member of the party asked to study and report upon the mining methods in Germany used to work the Cretaceous iron ores of the Salzgitter-Ilsede region, and the Dogger ores of Bavaria, Württemberg and Baden. While a member

of the Geological Survey, Dr. Taylor continued lecturing work at the Working Men's College, Crowndale Road, London, and has been a member of Council of that College for many years. It will be clear from these varied activities that Dr. Taylor is a man of personality and drive. He has had a wide experience in geological work in the class-room and in the field in Britain, America and on the Continent, and will bring a highly trained, versatile and well-balanced mind to the problems of university education in geology.

Engineering at the University of Leeds: Prof. D. G. Christopherson, O.B.E.

Dr. D. G. Christopherson, whose appointment as professor of mechanical engineering at the University of Leeds, in succession to the late Prof. W. T. David, has been announced, was educated at Sherborne School and University College, Oxford, where he took first-class honours in engineering science in 1937. He held a Henry Fellowship at Harvard University during 1938–39, and was for several years a member of Sir Richard Southwell's research team developing 'relaxation methods'. He was part author of the first paper in which the application of these methods to partial differential equations was presented, and his thesis for the Ph.D. degree in 1941 dealt entirely with this important branch of the work. During the period 1941–45, he was a member of the scientific staff of the Research and Experiments Department, Ministry of Home Security, and was made an O.B.E. in 1945. Dr. Christopherson was appointed a University demonstrator in the Department of Engineering, Cambridge, in April 1945, and was elected a Fellow of Magdalene College. In 1946 he was promoted to lecturer and in 1947 he became bursar of Magdalene. Though Christopherson has contributed papers on vibrations and structural problems, his interests lie mainly in the region of applied mechanics, and particularly in the theory of lubrication.

Holweck Prize and Medal: Prof. L. F. Bates

Dr. L. F. Bates, Lancashire–Spencer professor of physics in the University of Nottingham, has been awarded the Holweck Prize and Medal by the Société Française de Physique. The Holweck Prize was founded by the Physical Society as a memorial to Fernand Holweck, director of the Curie Laboratory of the Radium Institute in Paris, and to other French physicists who were killed by the Germans during the occupation. The Société Française de Physique founded the Holweck Medal in bronze for presentation to the prizewinner. The award is made annually, alternately to a French and to a British physicist, for distinguished work in experimental physics. Prof. Bates is a leading authority on experimental magnetism. His book "Modern Magnetism", which appeared in 1939, has achieved an international reputation, and a second revised and enlarged edition appeared last year. His original work in an experimental field known for its difficulty is distinguished by a technique which he has built up since 1924 entirely by independent effort. In particular, his work on the heat liberated in step-by-step magnetism in the hysteresis cycle has advanced knowledge in a field where progress has long been retarded by the experimental difficulties. His work on the changes of specific heat at the ferromagnetic Curie point and his investigations of other properties of ferromagnetic substances are outstanding. His investigations in magnetism constitute a solid body of successful achievement which commands attention and admiration both at home and abroad. Magnetism is a subject in which there is now much interest in France, as instanced by the work of Néel and his school, and Prof. Bates will be warmly welcomed when he delivers his lecture in Paris in the early summer.

University of Birmingham and the Midland Region

Among other topics dealt with by the Vice-Chancellor of the University of Birmingham (Sir Raymond Priestley) in his report to the Court of Governors is that of the cordial relations between the University and the Midland region. During the period 1935–47 the University received £1,450,000 in benefactions, excluding further promises under seven-year covenants of about £700,000, a fine record for its friends and supporters; and in this respect it surpasses all universities except Oxford. Local government grants, too, have substantially increased, facts which are regarded by the Vice-Chancellor as a recognition of success and a token of confidence. A significant development has been the establishment of the Midland Advisory Council on Industrial Productivity, "an attempt to gear the new development in Engineering Production (made possible by the generous benefaction of Messrs. Joseph Lucas, Ltd.) to the regional productive drive". The Lucas chair in the principles of engineering production, of which Prof. T. U. Matthew is the first occupant, has as its object postgraduate teaching and research on engineering production and the principles of industrial management. This Advisory Council is intended to promote closer liaison between Midland industries and the University of Birmingham in order to improve standards of productivity. A further expression of the support of industry is the generous provision by Tube Investments, Ltd., of £1,500 per annum for seven years for the establishment of a research fellowship in engineering production. The first holder of this fellowship is Mr. Mansergh Shaw, senior lecturer in engineering in the University of Melbourne. To assist Prof. Matthew in developing the postgraduate courses, Mr. P. B. R. Gibson has been appointed as lecturer, and lectures in engineering economics for final-year mechanical and electrical engineering students have been arranged as introductory to the postgraduate courses. It is expected that postgraduate students will be, in the main, sent by industrial firms; they will be expected to have had considerable industrial experience and to possess the attributes essential for success in management.

Philosophical Society of the Sudan

A nation is judged not only by its resources and productivity but also by its standard of scholarship and culture; and an indication of this may be estimated by its number and quality of learned societies. In company with the present-day awakening throughout Africa, the Sudan is, and has been, making great progress in the field of economic development and towards a larger measure of self-government. It is pleasant to report that learning is keeping pace with this development, and that the Philosophical Society of the Sudan, which was founded on February 2, 1946, is flourishing and setting a high standard. The *Proceedings* for 1946–47 record the activities of this Society for the first year of its existence. At the inaugural meeting seventy-five founder members were enrolled, and the officers and committee were elected. Soon after, at the first ordinary meeting, the president, Mr. A. J. Arkell, gave his address. After discoursing on archæological

discoveries in the district, he went on to stress the wide possibilities of local research in the various fields of archæology, geology and geography for piecing together the history of the Sudan, and also the need for research on modern aspects of Sudanese life, such as local industries and crafts, place-names, languages, customs, etc. Finally, there was the necessity for an adequate museum and library to consolidate and display the results of such research.

This presidential address seems to have been taken up by the members of the Society, for, during the year, papers were presented dealing specifically with the Sudan on the following subjects: archæological finds in local caves; manuscripts relating to the early Muslim period; distribution of types of soil and discoveries of fossils; relation between soils and local vegetation; Turkish administration during 1823–37; agricultural research; history during 800 B.C.—A.D. 350; and archæological finds (this last being another address by the president). Other papers which were of rather more general interest included such topics as transport, light reading in the Middle Ages, welfare and development, examinations, rates of evolution, and forestry. The Society is to be congratulated on a successful year and on its increase of membership to more than a hundred. The officers for 1948–49 are: *President*, Dr. J. Smith; *Vice-President*, G. W. Ogden; *Honorary Secretary*, A. W. Ireland; *Assistant Honorary Secretary*, L. S. Cobley; *Honorary Treasurer*, G. C. Wood. The address is the Secretary's Office, c/o General Post Office, Khartoum.

Limiting Factors in World Development

In his address, "Limiting Factors in World Development, or What is Possible", to the Associated Scientific and Technical Societies of South Africa at Johannesburg on August 11, 1948, Sir Harold Hartley suggested that a primary cause of our present troubles is the failure to realize that in the twentieth century, with the exploitation of the virgin lands, the slowing down of the growth of population and the disappearance of 'easy money', a new technique is required to give a dynamic impulse to international trade and stimulate both production and purchasing power. The future depends on increasing both production and purchasing power, and Sir Harold then examined more particularly the limiting factors in agricultural production. Of these, water comes first, and he stressed the importance of irrigation, draining and soil conservation. Climate comes next, and here we have the problem how far science can overcome the handicap of temperature extremes by improved living conditions, diet and clothing. Soil presents a very intricate and difficult scientific problem; but great advances are being made, although we are only now realizing the delicate balance in the top few inches of soil on which fertility depends. Next comes man-power and human skill, involving questions of education, physique and incentives if production is to be improved. Diseases and pests have been a major limiting factor; but here we have immediate reason for optimism in recent discoveries and developments both for protecting the individual and for the eradication of carriers of disease and destruction of pests themselves.

Transport is another determining factor by making possible the exchange of commodities and the movement of individuals, and Sir Harold stressed the value of air transport in opening up undeveloped regions. This factor is intimately linked with the economic factor of energy and power and the corollaries of equipment and capital, and in this connexion he said there must be a growing emphasis on the processing of farm and forest products; this is a great new field for the agriculturist and the chemical engineer. Finally, an orderly solution of the problems of production in any area depends on a survey of its natural resources, human geography, economic structure and capacity for production and consumption. The technique of making such surveys is in its infancy, and Sir Harold stressed the contribution of the aeroplane and of wireless. Moreover, the value of such national surveys would be enhanced by some clearing house through which the results could be made available for all countries. In human engineering, however, man is the limiting factor, and we are fighting once more for the freedom and ethical standards of Western civilization. Nevertheless, men with vision and imagination, with the power to foresee what modern methods can achieve, with confidence in the future and with human interest in the backward peoples and determination to improve their lot, will be the pathfinders in the quest of plenty.

National Research Council (Canada): Review of 1948

The "National Research Council Review, 1948" (N.R.C. No. 1713. Pp. 216. Ottawa: King's Printer, 1948. 75 cents) describes the work of the Council during the year ended December 31, 1947, and gives more detailed information regarding the work of the laboratories than is contained in the annual report, the last (thirty-first) of which covered the year ended March 31, 1948 (see *Nature*, November 6, p. 748). Besides the more specific accounts of work in progress, the Review includes a full list of scientific staff, arranged by Divisions, now totalling 2,682 persons, with details of the representation of the National Research Council on outside committees. In addition to statistics of scholarships and fellowships awarded in 1947–48 and their distribution, there is an analysis of those awarded during 1917–48. Reports from the various Associate Committees list the members of those Committees, while the value of the reports from the Divisions of Atomic Energy Research, Applied Biology, Chemistry, Applied Chemistry, Mechanical Engineering, and Radio and Electrical Engineering is enhanced by the inclusion of lists of publications of the Divisions during the year. The Review is thus a most useful annual reference work on the work of the Council. Reference has already been made (*loc. cit.*) to features of the work of the Council during the year. It can only be added here that besides giving a clear picture of the organisation and activities of the Atomic Energy Research Division, the Review refers to a development unnoticed in the annual report—the establishment of a new company, Canadian Patents and Developments, Ltd., with a board of directors of representatives from industry, the universities and the National Research Council. The primary purpose of this Company is to make available to industry through licensing arrangements the inventions, new processes and improvements in processes, developed by the scientific workers of the Council. It is anticipated that the Company will eventually have charge of all Government-owned patents which can be made available to industry, including some 1,300 enemy patents now held by the Custodian of Enemy Property. The Company is also intended to provide a channel for the flow to industry of new developments by scientific workers in the universities.

Ancient Pottery of the Near East

POTTERY sherds, when they occur, are some of the most useful 'fossils' the prehistorian can have to deal with. When they are found with an industry, one can be almost certain that they are contemporary. It follows, then, that a known ware imported from some distant region and found associated with an unknown industry will date that industry with reasonable accuracy as being contemporary with the culture which manufactured the particular ware in question. This is not so true in the case of beads. It is a fact, of course, that when the association is real and there has been no subsequent chance introduction, the industry with which the bead of known date is found must be either contemporary with it or later in date. But beads have a long survival value; necklaces made of Egyptian beads were popular in late Victorian times, thousands of years after they were made. Prehistoric housewives, however, smashed crockery as freely as their descendants, and the survival value of a pottery vessel in use is limited. Pottery, then, is particularly useful for correlating in time various cultural levels from different regions. We can therefore be grateful to Marian Welker, who in a paper entitled "The Painted Pottery of the Near East in the Second Millenium B.C. and its Chronological Background", has brought together in convenient form a wealth of detail of the pottery in the Near East at this period (*Trans. Amer. Phil. Soc.*, N.S., **38**, part 2; September 1948). The paper is arranged by sites and areas, considering especially a number of Syrian localities. The author considers that Mesopotamian influence on the development of the wares in these sites is sporadic and that we shall have to look rather to an Iranian cradle for their origin. Chronological tables and some pages of illustrations are included, and the resulting volume will certainly prove of great use to students. There are also a catalogue of forms and several pages of references.

Society of Public Analysts and Other Analytical Chemists

THE seventy-fifth annual general meeting of the Society was held on March 9 in the meeting room of the Royal Society, Burlington House, London, W.1, with the retiring president, Mr. Lewis Eynon, in the chair. In his address, Mr. Eynon began by remarking on the Society's membership of 1,500, a doubling of the figure of ten years ago; he announced that, in alternate years in which no change of president occurs, the lecture which is delivered at the annual general meeting will in future be known as the Bernard Dyer Memorial Lecture, in honour of the late Dr. Bernard Dyer. The main theme of Mr. Eynon's address was the fundamental importance of analysis to the progress of chemistry and the necessity for giving a prominent place to analysis in the training of the student of chemistry. He said that although two former presidents of the Society had both deplored the inadequacy of training in analytical chemistry, little advance has been made in the status of analysis as a subject of instruction in the universities and technical colleges of Great Britain; indeed, the position has if anything become worse owing to the increasing claims of other branches of the science on a student's time. The great utilitarian value of training in analysis is too obvious and manifold when one considers its application to industry, medicine, water supply and Government inspection. The most important practicable step is for the establishment of chairs of analytical chemistry in universities and colleges and for a longer period of training for the student. With the present unsatisfactory conditions of training there is a serious danger that within the next twenty years the analyst himself will be "weighed in the balance and found wanting".

The following officers and members of Council were elected for the ensuing year: *President*, George Taylor; *Past Presidents serving on the Council*, F. W. F. Arnaud, Lewis Eynon, E. B. Hughes, G. Roche Lynch, S. E. Melling, G. W. Monier-Williams; *Vice-Presidents*, C. A. Adams, H. E. Cox, J. R. Nicholls, J. G. Sherratt (chairman, North of England Section), J. Sword (chairman, Scottish Section); *Honorary Treasurer*, J. H. Hamence; *Honorary Secretary*, K. A. Williams; *Other Members of Council*, N. L. Allport, R. C. Chirnside, J. F. Clark, D. C. Garratt, J. G. A. Griffiths, E. T. Illing, J. King, J. E. Page, C. J. Regan, F. A. Robinson, N. Strafford, A. M. Ward, A. Lees (honorary secretary, North of England Section), R. S. Watson (honorary secretary, Scottish Section).

New Grassland Research Station at Hurley, Berks

A NEW Grassland Research Station for Great Britain is being established by the Minister of Agriculture and the Secretary of State for Scotland in co-operation with the Agricultural Research Council. The new Station will occupy an area of 500 acres at Hurley, Berkshire, adjoining the new Berkshire Farm Institute. Its work will be the investigation of problems relating to the sward and its production and maintenance under different conditions, but mainly under those of medium and low rainfall. The existing Grassland Improvement Station at Drayton, Stratford-on-Avon, will be transferred to and amalgamated with the new Station. The work at Hurley will be carried out in close co-operation with that of the Welsh Plant Breeding Station at Aberystwyth, the Scottish Society for Research in Plant Breeding and other research institutions, and it will be under the scientific supervision of the Agricultural Research Council. The Station will be controlled by a Governing Body which will be constituted as a company limited by guarantee and without share capital, grant-aid being given by the Ministry of Agriculture. The thirteen members who have been appointed to the Governing Body, and of which Prof. H. G. Sanders is chairman, provide a balanced representation of scientific knowledge and practical farming experience.

Liquid Helium-3

IN the *Physical Review* of January 15, p. 303, S. G. Sydoriak, E. R. Grilly and E. F. Hamel report that on October 13, 1948, they succeeded in condensing pure helium-3. This is especially interesting, since several physicists, F. London, Tisza, and others, have expressed doubts that helium-3 would liquefy. Twenty c.c. (measured at S.T.P.) of helium-3 were used, and condensation took place at the bottom of a 1·2-mm. bore stainless steel capillary immersed at a depth of 5–10 mm. in the liquid helium well. Condensation was assumed to be taking place when the equilibrium pressure in the capillary was independent of the volume of helium which remained in the mercury manometer connected to the room-temperature end of the capillary. From the data obtained, 3·3$_4$° K. was chosen as the critical temperature of helium-3. The vapour pressure measure-

ments showed that at 1·2° K. the vapour pressure of helium-3 was thirty-five times that of helium-4; helium-3 was suitable for thermometry at low temperatures down to 0·5° K. and perhaps lower; the normal boiling point of helium-3 was 3·2° K., and by extrapolation to the critical temperature the critical pressure was 875 mm. of mercury. A value of 0·041 gm./c.c. for the critical density was deduced.

Birds in London

In April 1947 the Minister of Works appointed a Committee on Bird Sanctuaries in the Royal Parks (England and Wales). For its general objectives the Committee decided to: (1) make suggestions for increasing the resident population of birds, their number and variety; (2) make suggestions for attracting migratory birds and for inducing unusual visitors to stay longer; (3) select competent persons as observers and reporters.

The Committee has now reported, and the results of its deliberations have been set out in a pamphlet, "Birds in London" (H.M. Stationery Office. 9*d*.). The first duty was the appointment and guidance of competent observers, and it is their statements which provide most of the material in the pamphlet. They show how successful has been the policy of developing the London bird sanctuaries, which were originally set up so long ago as 1923.

Young Children

To mark the year of its silver jubilee, the Nursery School Association of Great Britain has begun the publication of a new quarterly journal. This follows the formation of the World Council of Early Childhood Education after an international meeting in Prague in August 1948, and the new journal is intended to act as a link between all who are interested in the education of young children in any part of the world. Volume I of *Young Children* contains articles on the use of water play in the nursery, the stages of education which follow the nursery school and the links between home and school. The new journal has been produced unpretensively and should strengthen a side of education which has been much neglected by existing journals. It is doubtful, however, if the new journal will survive unless the price is reduced.

Hundredth Meeting of the Genetical Society

The Genetical Society of Great Britain, founded in 1919 by William Bateson, will hold its hundredth meeting during June 30–July 1, in Cambridge. To mark the occasion guest speakers will review the early days of genetics, and there will also be comprehensive demonstrations of genetical work now in progress in Great Britain. Genetical societies abroad have been informed of this meeting, to which all geneticists are cordially invited. Details may be obtained from the secretaries, G. Pontecorvo, Department of Genetics, University, Glasgow, W.2, or H. G. Callan, Institute of Animal Genetics, University, Edinburgh 9.

The Night Sky in April

Full moon occurs on April 13d. 04h. 08m., U.T., and new moon on April 28d. 08h. 02m. The following conjunctions with the moon take place: April 9d. 13h., Saturn 3° S.; April 20d. 03h., Jupiter 5° N.; April 29d. 21h., Mercury 0·7° S. Mercury is in superior conjunction on April 13 and is not favourably placed for observation until later in the month; the planet sets 1h. 45m. after the sun on April 30, and can be seen in the western sky. Venus, in superior conjunction on April 16, is too close to the sun for favourable observation throughout the month. Mars rises about the same time as the sun during April, and cannot be observed. Jupiter is a morning star, rising at 3h. 20m., 2h. 30m. and 1h. 35m., at the beginning, middle and end of the month, respectively, and can be seen low down for a few hours before sunrise. Saturn sets in the early morning hours and is visible throughout the greater part of the night. Occultations of stars brighter than magnitude 6 are as follows: April 1d. 19h. 46 3m., 45 Arie. (*D*); April 7d. 00h. 31·4m., *c* Gemi. (*D*); April 11d. 20h. 56·3m., η Virg. (*D*). *D* refers to disappearance, and the latitude of Greenwich is assumed. The Lyrid meteor shower is active about April 18–24. A total eclipse of the moon, visible at Greenwich, takes place on April 13, the circumstances of which are given as follows: moon enters penumbra, 01h. 31·6m.; enters umbra, 02h. 27·7m.; total eclipse begins, 03h. 28·0m.; middle of eclipse, 04h. 10·9m.; total eclipse ends, 04h. 53·8m.; moon leaves umbra, 05h. 54·1m.; leaves penumbra, 06h. 50·3m. A partial eclipse of the sun, visible at Greenwich, occurs on April 28, its magnitude being 0·41 at Greenwich, where it begins at 6h. 21m., reaches its greatest phase at 7h. 15m., and ends at 8h. 14m.

Announcements

On the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1948 to Sir Edward Appleton. The medal is awarded annually, and was founded in 1936 in memory of Sir Alfred Ewing. This award has come appropriately when Sir Edward has just taken up his appointment as vice-chancellor of the University of Edinburgh, a position which Sir Alfred Ewing occupied with such distinction.

Dr. R. P. Linstead, director of the Chemical Research Laboratory, Teddington, since 1945, has accepted the invitation of the University of London to succeed Sir Ian Heilbron as professor of organic chemistry and director of the Organic Chemistry Laboratories at the Imperial College of Science and Technology as from April 1, or as soon afterwards as can be arranged.

M. Gaston Dupouy has been elected *correspondant* for the Section of General Physics of the Paris Academy of Sciences in succession to Prof. W. J. de Haas, who has been elected a foreign associate.

A division of the Royal Aeronautical Society has recently been formed in South Africa on the same lines as those formed in Australia and New Zealand in October 1948. Associate fellows will still be elected by the parent body of the Society in London; but otherwise these Divisions of the Commonwealth will possess a fully self-governing status and will be free to develop along their own national lines.

The Royal Photographic Society will be holding its annual exhibition at 16 Princes Gate, London, S.W.7, in two parts: part 1 (pictorial and colour), September 9–October 2; part 2 (scientific, Nature, medical, record, press, commercial, industrial, technical and radiographic), October 8–26. Admission will be free. Entries must be received by July 23, and entry forms may be obtained from the Secretary at the above address.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Analgesic Drug Analogous to *iso*Amidone

In the course of our search for new analgesics free from undesirable side-effects, 6-piperidino-4 : 4-diphenyl-5-methyl-3-hexanone (III) (the piperidyl analogue of *iso*amidone) has been synthesized by the following route:

$$Ph_2CH.CN + ClCHMe.CH_2NC_5H_{10} \rightarrow$$
(I)

$$Ph_2C(CN).CHMe.CH_2NC_5H_{10} \rightarrow$$
(II) (HCl, m.p. 225–226°)

$$Ph_2C(CEt:NH).CHMe.CH_2NC_5H_{10} \rightarrow$$
(2HCl, m.p. 193°)

$$Ph_2C(COEt).CHMe.CH_2NC_5H_{10}$$
(III) (HCl, m.p. 197–198°)
(HBr, m.p. 208–209°)

In the combined synthesis of amidone and *iso*amidone it has been shown that at least two isomeric nitriles are formed by the condensation of diphenylacetonitrile (I) and 1 (or 2)-chloro-2-(or 1)-dimethylaminopropane, owing to ring formation in the latter[1], and in view of the isolation of a third isomer of amidone[2] other chemical mechanisms may also operate. As the synthesis shown in the above scheme does not, therefore, establish the structure of the product, this was elucidated by the process of exhaustive methylation on the penultimate nitrile (II) on lines similar to those described by Schultz, Robb and Sprague[3].

Degradation of the nitrile (II) gave *N*-methylpiperidine (picrate, m.p. 222°[4]) and 2 : 2-diphenyl-3-methylbutenenitrile, m.p. 64–65°, apparently identical with that obtained by the American workers[3]. On hydrogenation it gave 2 : 2-diphenyl-3-methyl-*n*-butylamine, of which the phenyl urea derivative, m.p. 204–205°, was identical with a specimen synthesized by an independent method. Work is now proceeding with the view of isolating any other isomer of (III) that may be formed.

The piperidyl analogue of *iso*amidone has proved of considerable pharmacological interest, since it shows the smallest degree of undesirable side-actions of any of the active analgesic drugs we have yet studied. The methods used for the assessment of toxicity, analgesic and respiratory depressant activities have been described[5,6], and the results obtained with this compound are shown in the accompanying table, together with the figures previously reported for amidone and *iso*amidone. In all cases morphine has been used as the standard for the measurement of analgesic and respiratory depressant actions.

'Piperidyl *iso*amidone' (III) shows the same effects in acute animal toxicity experiments as amidone or *iso*amidone, death in all cases resulting from acute cardiac failure. All these compounds differ from morphine in this respect, since they are many times more toxic upon rapid intravenous injection than is morphine, although the toxicities in sub-acute experiments are very much more similar to that of morphine. All the compounds referred to, with the exception of morphine, are toxic to the isolated rabbit heart (Langendorff's preparation) at concentrations stronger than 1 part in 100,000, although 'piperidyl *iso*amidone' alone shows appreciable coronary dilator activity in concentrations below this figure.

Compound	Toxicity (I.V. mice) mgm./kgm.	Analgesic activity: Equi-active doses mgm./kgm.	Analgesic activity: Approximate ratio	Respiratory depressant activity: Equi-active doses mgm./kgm.	Respiratory depressant activity: Approximate ratio
Morphine	—	3·0	1·0	4–5	1·0
Amidone	12·5–25*	2·2–2·5	1·3	2·5	1·4–2·0
*iso*Amidone	40	3·0	1·0	7–10	0·4–0·7
'Piperidyl *iso*amidone'	25	3·0	1·0	12	0·3–0·4

* The toxicity of amidone and its optical isomers in mice is greatly influenced by the strain of animals employed, the published figures showing very wide variations.

In man 'piperidyl *iso*amidone' in doses of 12·5 mgm. produced no appreciable side-actions. When the dose was increased to 25 mgm., some of the volunteers described a sensation of warmth, were flushed and slightly dizzy, although the symptoms were less pronounced than those we have observed with other analgesic drugs. This drug was without significant effect upon the cardio-vascular system.

The depressant effect of 'piperidyl *iso*amidone' upon the respiratory response in human subjects to the inhalation of 5 per cent carbon dioxide in oxygen was examined by Prescott, Thorp *et al.*[7], and shown to be far less than that produced by equivalent analgesic doses of morphine, pethidine, amidone, *iso*amidone or Hoechst compound 10582, and to be approximately one third that of morphine.

From the table it would appear that *iso*amidone itself should be a superior drug to amidone; but in a few patients given *iso*amidone it was found that the duration of analgesic action was too short for the drug to be of real value. On the other hand, 'piperidyl *iso*amidone' produced analgesia similar in duration to that of amidone, and has shown sufficient promise to warrant an extensive examination and clinical trials, particularly in obstetrics, and the results of this work will be reported elsewhere.

Note added, January 10. Recently a second nitrile hydrochloride, m.p. 199–200°, isomeric with the hydrochloride of (II), has been isolated and converted into the corresponding ethyl ketone (6-piperidino-4 : 4-diphenyl-3-heptanone, $Ph_2C(COEt).CH_2.CHMe.NC_5H_{10}$) (HCl, m.p. 118–120°). Preliminary results obtained by Dr. A. C. White and Mr. A. F. Green, using young rats, indicate that this ketone is approximately twice as active as morphine analgesically, yet only equal to it as a respiratory depressant.

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Sept. 29.

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Constitution and Properties of Laccase

It was shown that laccase, which had been inactivated by cyanide under certain conditions, could be almost completely re-activated by cupric ions, whereas other metals were ineffective[1]. Further evidence will be presented here to show that copper is an essential constituent of this enzyme. Laccase was purified by the method of D. Bertrand[2,3]. At each successive stage of purification the enzyme activity was measured in the manner previously described[1], and copper and manganese were estimated by microchemical methods[4,5]. Manganese disappears after the first steps of purification; the copper content increases with the Q_{O_2} and remains proportional to activity in all fractions up to the purest preparation having Q_{O_2} 30,000 in presence of *para*phenylene diamine (Fig. 1).

In recent papers, D. Bertrand has described three important properties of laccase which will be re-examined here. It is claimed that the activity of this enzyme is much more sensitive than that of other enzymes to small variations of *p*H [6]. For example, with pyrogallol as substrate, the 'relative Q_{O_2}' is said to fall from 10,000 to 1,500 when the *p*H changes from 6·5 to 7·0. On repeating these experiments, I found that the sensitivity of laccase to *p*H variations is no greater than is generally the case with enzymes, and that optimum activity is observed at *p*H 7·4 with pyrogallol and at *p*H 7·0 with *para*-phenylene diamine (Fig. 2).

Furthermore, D. Bertrand found that laccase, like cytochrome oxidase, has the property of oxidizing cytochrome *c*[7,8] and cystein[9], and this led him to believe that the two enzymes are probably closely related. However, if laccase is added to reduced cytochrome *c* and the mixture shaken in air, no spectroscopic change occurs. The oxidation of cytochrome *c* has also been studied manometrically in the way described by D. Bertrand[7,8]. Thus the oxygen uptake at 20° C. of a system consisting of laccase and 10 mgm. hydroquinone in 3·3 ml. phosphate buffer, *p*H 7·1, was only increased by 5–7 per cent by the addition of 0·2 ml. of 1 per cent cytochrome *c*. Since, however, the quantity of cytochrome *c* used in such experiments is at least thirty times greater than the quantity of laccase (assuming that pure laccase has a $Q_{O_2}^{*}$ of 20,000 in the oxidation of hydroquinone), the resulting increase in oxygen uptake is insignificant, and there is thus no indication that cytochrome *c* is oxidized by laccase.

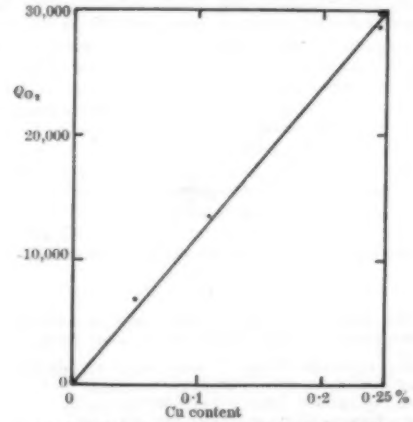

Fig. 1. Relation between the activity of the enzyme (Q_{O_2}) and the copper content

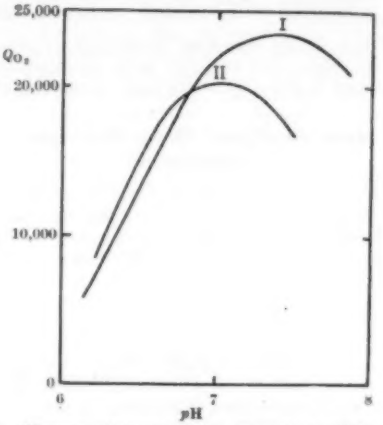

Fig. 2. *p*H curves of laccase activity. Curve I was obtained with pyrogallol and curve II with *para*phenylene diamine

The methyl ester of cystein, as well as cystein itself, is said to be oxidized by laccase[9]. It was claimed that this oxidation has the unusual feature that the *p*H activity curve shows two well-marked optima at *p*H 6·7 and 7·45, at which the rate of oxygen uptake is 31 and 27 per cent respectively of that by hydroquinone at *p*H 6·35. On repeating these experiments in Barcroft manometers, it was found that cystein was not oxidized at all by laccase, even after shaking for thirty minutes. The slow rate of oxygen uptake observed with laccase and cystein methyl ester represented only 5–8 per cent of that found with laccase and *para*phenylene diamine. Moreover, a study of the effect of *p*H on this slow oxidation revealed not two optima, but one at 7·1, and the *p*H activity curve was of the usual type. As laccase does not oxidize cystein, and as its effect on the methyl ester is very small, the conclusion that cystein can be oxidized directly by laccase is not justified.

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Investigations with Radioactive Penicillin

Much of the published data regarding the mode of action of penicillin is necessarily concerned with secondary effects on bacteria, for example, rate of killing under different conditions, morphological changes, etc. By use of radioactive penicillin, it should be possible to find out directly something of the nature of the primary reaction between penicillin and the cell.

In a previous communication[1], we have described attempts to measure the amount of penicillin involved in the killing of bacteria, which gave no positive

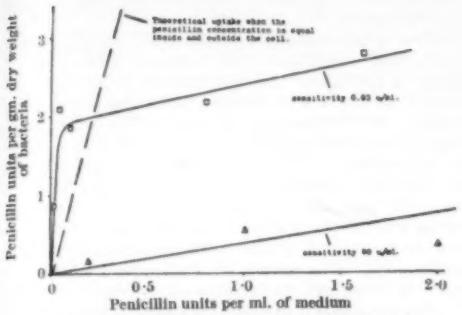
Theoretical uptake when the penicillin concentration is equal inside and outside the cell.
sensitivity 0.03 u/ml.
sensitivity 40 u/ml.
Penicillin units per gm. dry weight of bacteria
Penicillin units per ml. of medium

Fig. 1. Penicillin uptake on resting staphylococci

results. In these preliminary experiments we assumed that self-absorption of the β-rays by bacteria would be considerable, and accordingly looked for a disappearance of radioactivity from the filtrate, rather than an increase on the bacteria. Further experiments have shown that this self-absorption effect can be eliminated by counting thin films of bacteria, and under these conditions we have been able to detect a penicillin uptake.

Bacteria were suspended under various conditions in radioactive penicillin solutions, centrifuged, washed and the radioactivity on the bacteria measured directly by the Geiger counter, the uptake being expressed as units of penicillin per gm. dry weight of the cells, as this avoids any assumptions regarding size of bacteria, etc., made when calculated in terms of molecules attached per organism. The penicillin uptake is very small, varying from a maximum of 40 units per gm. dry weight down to the smallest detectable amount of 0·5 units per gm., this variation depending on the strain of the organism and conditions of experiment.

Penicillin is taken up by all bacteria in amounts which increase with penicillin concentration in the external environment. In the range of 0–0·5 u./ml., however, there is a marked qualitative difference in the shape of uptake curve for sensitive and resistant organisms (see Fig. 1), so that, at these minimal concentrations, much more penicillin is fixed by sensitive than by resistant bacteria. There is, in fact, a direct correlation between the sensitivity of an organism and the amount of penicillin attached to it. The uptake increases greatly when growth occurs in presence of penicillin (see Fig. 2). However, if growth is halted by cooling, or if the cells are already dead, there is still a rapid but smaller uptake.

The penicillin is strongly and irreversibly attached under all conditions of reaction, and cannot be removed by washing or by incubation for 30 min. with 0·1 per cent cetyl trimethyl ammonium bromide or 'Aerosol OT', 5 per cent phenol, 1 per cent cysteine, 1 per cent sodium hydroxide, *N* hydrochloric acid, 1 per cent glucose or with ordinary penicillin (200 u./ml.); it is, however, removed by heating for five days at 60° C. in water.

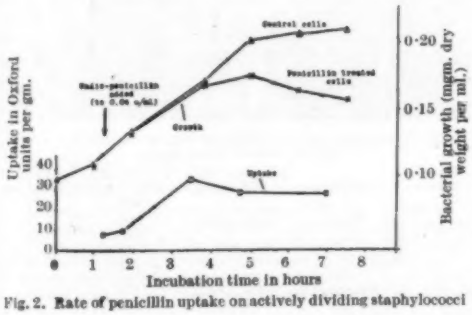

Fig. 2. Rate of penicillin uptake on actively dividing staphylococci

The site at which penicillin is attached to resting cells is not blocked by pre-treatment of the cells with 3 per cent formalin, 0·1 per cent cetyl trimethyl ammonium bromide, 0·1 per cent euflavin, *N* hydrochloric acid, or by autoclaving; but heating for five days at 60° in water or pre-treatment with penicillin or acetic anhydride completely prevents any uptake.

Whatever the nature of the primary site of penicillin action, it is clear from this and other work that rapid growth exposes more centres in the bacteria with which the penicillin can react. The combination must either be by unusually strong adsorptive or by chemical forces.

We are grateful to Dr. E. Lester-Smith for further preparations of radiopenicillin and to Mr. P. Roberts for his help in maintaining the counter.

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Electrophoretic Properties and Analysis of Whale Myoglobin

In a recent note[1] describing the preparation of whale myoglobin, it was shown that this protein could be crystallized as the carboxy- or met-myoglobin.

In continuation of this work, an electrophoretic study has been carried out using the Tiselius apparatus. The myoglobin was dissolved to give a 1 per cent solution in phosphate buffers of ionic strength 0·1 at *p*H values between 4 and 11. Only above *p*H 11 or below *p*H 4·6 was a single boundary observed. At all intermediate *p*H values two or three boundaries were present.

Globin hydrochloride was prepared by the method of Anson and Mirsky[2], which has already been used with success by Drabkin[3] in the case of horse myo-

Globin of whale myoglobin

(1) N as % protein–nitrogen.
(2) gm. Amino-acid per 100 gm. protein.
(3) Minimal mol. wt. calculated from data in (2).
(4) Assumed number of residues.
(5) Apparent minimal mol. wt. of protein, calculated from data (3) and (4).

	(1)	(2)	(3)	(4)	(5)
Arginine	4·25	2·24	7760	2	15520
Histidine	17·78	11·12	1391	12	16710
Lysine	17·94	15·90	918	19	17450
Glutamic acid	9·74	17·40	845	20	16900
Aspartic acid	3·98	6·41	2068	8	16544
Amide-N (ammonia)	3·35	0·69	2460	7	17220
Methionine	1·03	1·86	7950	2	15900
Tryptophane	2·10	2·60	3921	4	15684
Serine	2·12	2·69	3882	4	15528
Threonine	2·95	4·26	2790	6	16740
Glycine	4·44	4·04	1856	9	16700
Alanine	7·82	8·46	1053	16	16870
Proline	1·70	2·38	4845	4	19380
Phenylalanine	1·98	3·96	4160	4	16640
Leucines	11·30	17·96	729	23	16770
Valine	2·64	3·74	3120	5	15600
Tyrosine	0·96	2·12	8570	2	17160
Cyst(e)ine	0·00	0·00	0	0	0
Hydroxyproline	0·00	0·00	0	0	0
Hydroxylysine	0·00	0·00	0	0	0
Total found	96·08	107·83	—	147	16700 (mean)

globin. The native product became denatured readily, though in two out of six experiments a clear solution was obtained in 3 *M* phosphate buffer at *p*H 7·0. Such solutions nevertheless were too unstable for electrophoretic examination. The denatured globin, which was soluble below *p*H 4·0 and above *p*H 10·0, gave the expected picture of a single sharp ascending boundary with a very diffuse descending boundary.

A preparation of the globin, obtained by precipitating twice with acetone–hydrochloric acid followed by heat coagulation, contained 17·0 per cent nitrogen, corrected for ash. Amino-acid analyses were made by methods in current use in this laboratory, and the results are collected in the accompanying table. The minimum molecular weight would appear to be about 16,700. Application of the end-group assay method of Sanger[4] suggests that the molecule may be a peptide chain bearing a terminal valyl residue.

I wish to thank Prof. A. C. Chibnall for his advice and encouragement, and the "Stiftung für Stipendien auf dem Gebiete der Chemie" for a grant.

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Oct. 29.

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Role of Substances Formed during Germination in the Growth of Plants

In this laboratory, v. Hausen[1] showed in her doctoral thesis that if the cotyledons of a pea plant are removed after a germination period of five to nine days, and the cotyledonless seedling is transferred into a sterile nutrient solution (the sterile culture system of Virtanen and v. Hausen[2]), it grows at first poorly and small chlorophyll-containing leaves are formed; but growth soon ceases. If crystalline ascorbic acid (30–40 mgm. per pea plant) was added to the nutrient solution (1 litre per pea plant) the plant grew until the flowering stage. Since the cotyledons of the pea at this stage of development contain more than 90 per cent of the vitamin C formed during germination, this experiment gave convincing proof for the conclusion[3] drawn from the previous observations that vitamin C is a growth hormone of plants and indispensable for their life.

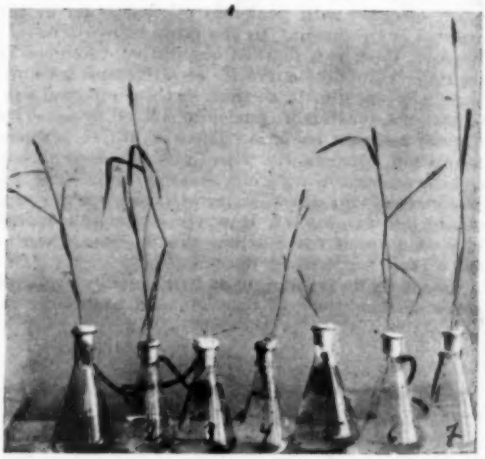
This problem has again been under investigation in this laboratory during the last two years. Saubert-v. Hausen[4] has already reported on experiments which show that the B-complex and biotin also promote to a certain extent the growth of cotyledonless peas. The effect of vitamin C is, however, much superior. The effects of various vitamins are additive.

The purpose of our new experiments has been in the first place to clarify the mode of action of vitamin C. At first we found that large doses of vitamin C (100–120 mgm. ascorbic acid per pea plant, administered in three doses) produced in some cases with cotyledonless seedlings a growth comparable with the normal growth. In the previous experiments with smaller doses of vitamin C (30–40 mgm.) the growth was much weaker. Our experiments showed also that amino-acids and especially the expressed juice of the growing pea promote to a certain extent the growth of cotyledonless peas. The growth was, however, not comparable with the response obtained with vitamin C.

All the experiments reported above were performed in nutrient solutions with calcium nitrate as the source of nitrogen. As the idea that ascorbic acid would function as a reducing system did not seem impossible, we carried out a number of experiments using ammonium sulphate as the source of nitrogen. The experiments were made both with cotyledonless peas and endosperm-free wheat plants. In the wheat grain, the vitamin C content of the embryo increases during two or three days to such an extent that the vitamin C content of the endosperm largely loses its significance. The wheat embryo must therefore be removed from the endosperm at a very early stage in order to obtain a distinct response to the vitamin C addition to the nutrient solution. In our experiments the wheat embryo was excised one or a few hours after the moistening of the seed. From a pea plant, in which vitamin C accumulates in the cotyledons, these were removed four to five days after moistening the seeds.

The results with wheat have shown consistently in all experiments that the excised embryo grows very poorly in a nutrient solution where nitrate is used as the source of nitrogen unless supplied with vitamin C. In a nutrient solution containing vitamin C the growth is again good. When ammonium sulphate is used as the source of nitrogen, the wheat embryo grows fairly well without vitamin C, nor does the addition of vitamin C improve the growth; on the contrary, it depresses growth to some extent (see photograph).

With pea the results in nutrient solutions with ammonium salts are not so distinct and consistent as with wheat. Difficulties are added in the first place by the fact that the pea takes up ammonium ions so rapidly[5] that ammonium salts in amounts injurious to growth are easily accumulated in the



Effect of ascorbic acid and different sources of nitrogen on the growth of isolated wheat germs

No. of expt.	Additions	Source of nitrogen	Dry weight of seedling (mgm.)	Length of shoot (cm.)
1	None	$(NH_4)_2SO_4$	520	37
2	,,	,,	720	46
3	,,	$Ca(NO_3)_2$	11	11
4	,,	,,	123	28
5	,,	,,	38	12
6	Vitamin C	$(NH_4)_2SO_4$	370	37
7	,,	$Ca(NO_3)_2$	542	56

plant. The light conditions and other factors affecting growth determine whether the pea grows well on ammonium salts or whether it withers. All this makes it difficult to carry out experiments on peas with ammonium nitrogen. In any event, even with peas a fairly good growth was induced in some experiments by means of ammonium sulphate without addition of vitamin C, and no improvement of growth resulted from vitamin C administration. In most cases the addition of vitamin C was harmful, perhaps because the oxidation-reduction potential was lowered too much.

The results suggest that the effect of vitamin C in plants is at least partly based upon the reducing properties of this vitamin. Regulation of the redox potential is apparently the important function of this vitamin in plants.

Our results show likewise that the prevailing concept that immediately after the appearance of chlorophyll the plant forms all its organic material through assimilation of carbon dioxide, in other words, is autotrophic for its metabolism, does not as such hold good. The plant needs the substances formed in the seed during germination often for a long time after the development of the first green leaves. This period varies in different plants.

The close dependence of the growth of plants on the substances formed in the seeds suggests that the productiveness of the different varieties of the same plant may perhaps depend on the quantity of such substances formed during germination. The elucidation of this problem, which is of much interest for the breeding work, requires extensive analytical material.

Note added in proof, March 12. Later experiments have confirmed the view that the reducing properties of vitamin C are of high significance. In addition to vitamin C many other substances, such as reductone, cysteine and glutathione in suitable concentrations promote growth in nutrient solutions with nitrate as the source of nitrogen. With ammonium salts these reducing substances are either ineffective or, in somewhat higher concentrations, injurious. Our measurements have also shown that vitamin C as well as other reducing substances added to the substrate lower the redox potential within the plant. Except in the above-described system, we have examined the growth of germs also in the dark on agar substrate which in addition to mineral salts contained 4 per cent[6] cane sugar. Generally the results were in agreement with those above.

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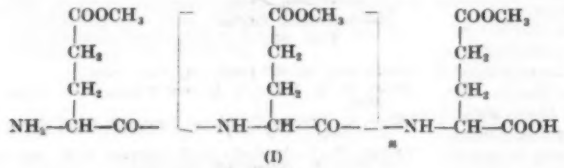
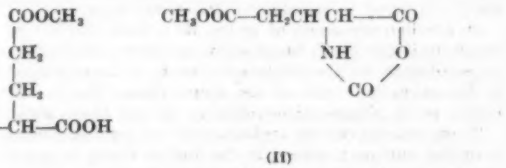
Evidence of Chain Folding in a Synthetic Polypeptide and in Keratin

A STUDY of polypeptides prepared by Leuchs's method[1,2] is being carried out in this Laboratory. We have recently prepared the polypeptide I (below) by the polymerization of the N-carbonic anhydride of γ-methyl L-glutamate (II), and wish to describe here observations which indicate that it has a folded structure as shown in III.



(I)



(II)

A small number of initiating centres were formed by exposing the anhydride to water vapour, and the specimen was left to polymerize in the solid state for three months in a desiccator. The polypeptide prepared in this manner was insoluble in the usual organic solvents; it dissolved readily in formic acid and slowly in *meta*-cresol. The specific viscosity measured in *meta*-cresol was 0·42 ($C = 1·00$ gm./100 c.c.), corresponding to a molecular weight of about 30,000.

Films of the polypeptide could readily be cast from hot *meta*-cresol solution; these films were coherent and pliable. A film of the polypeptide was cast on a thin smooth sheet of cadmium and rolled to produce an extension of 500 per cent. After rolling, the film was still coherent and flexible and showed double refraction, the maximum polarizability being in the direction of extension ($\Delta n = 0·0076$).

The spectrum of the extended film was examined by a polarizing infra-red spectrometer of high resolving power. The optical density of the specimen could be measured accurately with the electric vector of the incident radiation parallel and perpendicular to the direction of extension[3]. The results obtained in the 3 μ-region of the spectrum for bands which could be accurately analysed are given in the table.

Polyglutamic ester stretching-frequencies

Band frequency	Assignment	Dichroic ratio
3,305 cm.$^{-1}$	N—H stretching (hydrogen-bonded)	1·26
3,076	N—H vibration	1·80
2,851	CH_2 or CH_3 symmetrical stretching	0·60

The dichroic ratio is the ratio of the optical density of the absorption band with the electric vector parallel to the direction of extension to the density with the electric vector perpendicular to this direction.

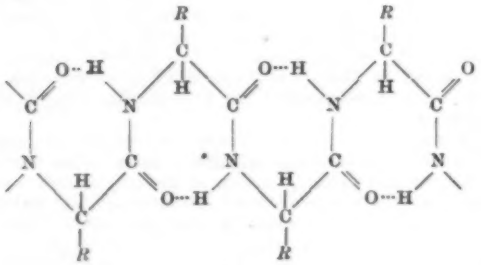
The bands at 3,305 and 3,076 cm.$^{-1}$ are practically identical with those of nylon 66 (3,308 and 3,078 cm.$^{-1}$), and are characteristic of many mono-substituted amides and polyamides. The band at 3,305 cm.$^{-1}$ is due to the N—H stretching-frequency in the hydrogen-bonded state. The band at 3,076 cm.$^{-1}$ may either be an overtone of the 1,550 cm.$^{-1}$ frequency or it may be due to the N—H stretching, accompanied by close hydrogen-bonding such as may occur in nylon. It is certainly an N—H frequency, and has been discussed from this point of view by Astbury, Dalgliesh, Darmon and Sutherland[4].

Polyglutamic ester shows the surprising result that the maximum absorption due to both bands is parallel

to the direction of extension, which indicates that the N—H bonds tend to lie parallel to the chain axis. The dichroic ratio is not large and suggests merely a preferred orientation of the N—H bond towards the chain axis. By examining the specimen with the radiation incident in several different directions, it has been shown that the above result is not due to the unlikely event of the chains being oriented perpendicular to the direction of rolling. Preliminary observations on the band at 1,650 cm.$^{-1}$ due to the peptide C : O stretching-frequency also indicate that the C : O bond is parallel to the chain axis.

In a rolled specimen of nylon 66 [3], both the N—H bands and the C : O band show stronger absorption perpendicular to the chain axis, as is to be expected in the extended form of the chain where the N—H bonds lie in planes perpendicular to the chain axis.

These results can be explained if the peptide chain is folded and maintained in the folded state, in spite of the extending force, by *intra*-chain hydrogen-bonding between the N—H and C : O groups (III), in which the N—H groups are inclined towards the chain axis.



(III)

It is likely that this folding is a direct consequence of the steric hindrance to *inter*-chain hydrogen-bonding, produced by the bulky side-chains. The folding of peptide chains in natural proteins has, of course, been suggested by Astbury[5]. Picken[6] has suggested that protein chains can exist in various configurations with the same internal energy, the extended form being the least probable. The folded configuration proposed for rolled polyglutamic ester should possess the same internal energy as the *inter*-chain hydrogen-bonded peptide. It may be that this folded structure exists largely in the non-crystalline regions of the polymer.

Results similar to the above have been obtained with a polyglutamic ester of molecular weight about 15,000 prepared by polymerization in solution.

Polarized infra-red observations of the highly oriented α-keratin obtained from the quill tip of *Atherurus africanus* have also given results similar to the synthetic polypeptide. MacArthur[7] has shown that porcupine quill is one of the most highly oriented available forms of α-keratin. The infra-red results indicate that α-keratin is also folded in the same way as the synthetic polypeptide and forms an extended ribbon-like molecule. The side-chains and seven-membered rings will both lie approximately in the plane of the ribbon. Huggins[8] has suggested the possibility of a similar seven-membered ring for α-keratin, but has adopted a different arrangement of the *R* and H groups about the asymmetric carbon atom. He also favours an arrangement with close spiralling of the ribbon. A spiral structure in a closely packed system does not seem to be consistent with the ease of effecting the α-β transformation, and a close spiral certainly will not account for the infra-red results.

Infra-red and X-ray investigations are now being carried out on other synthetic polypeptides and proteins.

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Structure of Chitosamine

In a recently published paper[1], it was shown that a number of aldose sugars are oxidized at characteristic rates by the action of hypoiodous acid. The rate of oxidation appears to be related to the structural configuration for any particular aldose; thus glucose and xylose show a similar rate of oxidation, which is, however, different from that shown by galactose and arabinose, and different again from that shown by mannose. The magnitude of these variations in the rate of oxidation is sufficiently great to enable a positive identification of the configurational group to which any one of these aldoses may belong. This work (*loc. cit.*) suggested that kinetic measurements of the hypoiodous acid oxidation of sugar derivatives of the aldose type might yield valuable information on the structure of such derivatives.

Chitosamine hydrochloride, for a pure sample ($\alpha_D^{20} = +72{\cdot}5$) of which, prepared from the carapace of *Jasus Lalandii*, I am indebted to Dr. J. B. Polya, was submitted to the oxidation procedure, and its rate of oxidation found to coincide closely with that of the galactose–arabinose group of aldoses. The experimental results are shown in the accompanying table, glucose and mannose being added for purposes of comparison.

Time of quarter change (sec.)

pH	Chitosamine hydrochloride	Galactose	Arabinose	Glucose	Mannose
10·55	4·25	4·25	4·25	6·5	28
10·95	3·25	3·25	—	4·5	18·5
12·80	15·0	16·25	16·0	32·0	175

This result is surprising, since the configuration of chitosamine has generally been accepted on what appears to be reliable evidence as that of glucose[2].

The results reported here may indicate, therefore, that chitosamine in strongly alkaline solution exists in some other modification than a pyranose ring (possibly a high percentage of the free aldehyde form), since only those aldoses which have a pyranose

ring have been studied in previous oxidation experiments[2]. The products of the oxidation reaction are at present being examined with the view of clarifying this point.

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[1] Ingles and Israel, *J. Chem. Soc.*, 810 (1948).
[2] Annual Reports, 78 (1922). Micheel and Micheel, *Ber.*, **65**, 253. Haworth, Lake and Peat, *J. Chem. Soc.*, 271 (1939).
[3] *loc. cit.* See also Myrbäck, *Svensk. Kem. Tidsk.*, **51**, 7, 74, 149, 179, 206, 225 (1939); **52**, 21, 200, 293 (1940).

Stability of Aminobenzyl-Quaternary Salts

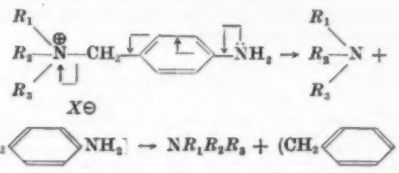
While engaged in the preparation of benzyl-quaternary salts of a number of N-heterocyclic ring systems, the abnormal instability of some salts containing the aminobenzyl group was observed.

When, for example, *o*- or *p*-nitrobenzylquinolinium chloride was reduced under neutral conditions (ferrous hydroxide or iron powder and water), the desired amino-compound was difficult to isolate, and the only recognizable product (yield *c.* 80 per cent) was quinoline. The first conclusion, that here was a particularly facile case of reductive debenzylation, had to be abandoned on further investigation. Thus, when *p*-nitrobenzylquinolinium chloride was hydrogenated in aqueous solution in the presence of palladium–charcoal and more than one mole of hydrochloric acid, six hydrogen atoms were absorbed, and the filtrate could be evaporated in a vacuum at a low temperature to leave *p*-aminobenzylquinolinium chloride hydrochloride as almost colourless hygroscopic crystals. In the dry state this was fairly stable over several weeks, and in solution it could be diazotized normally and coupled, for example, with β-naphthylamine in acid solution. The colourless solution of the hydrochloride, on treatment with sodium acetate, turned orange and deposited orange-yellow needles of the free amino-compound. This had a very low order of stability. It could be dried rapidly in a vacuum and analysed, but could not be recrystallized; warmed gently with water, it first dissolved but then rapidly decomposed to give quinoline in high yield and a brown amorphous material. In the dry state decomposition was apparent after a few days. Acetic anhydride converted the aqueous suspension into *p*-acetamidobenzylquinolinium chloride, a crystalline substance stable to boiling water.

On the other hand, *m*-aminobenzylquinolinium chloride hydrochloride, prepared in a similar manner to the *p*-isomer, was a non-hygroscopic substance, the aqueous solution of which was quite stable to boiling after the addition of sodium acetate. The free amino-quaternary iodide formed orange-red crystals from methanol.

Further work has since shown similar properties (*p*-amino, unstable; *p*-acetamido- and *m*-amino, stable) in the aminobenzyl-quaternary salts of *iso*quinoline, pyridine and phenyldimethylamine, as well as a number of *bz*-substituted quinolines. In the case of *p*-aminobenzylpyridinium chloride, the facile decomposition was probably observed by Lellmann and Pekrun[1]; but the significance was not explained.

It is suggested that the explanation for these observations may be that shown diagrammatically below; the strain in the benzyl-N bond due to the



presence of the adjacent positive charge is magnified to the point of actual rupture by the electromeric effect of a *free* amino-group in the *o*- or *p*-position. The greater stability of the *m*-isomer as well as that of the salts and acetyl-derivatives of the *o*- and *p*-isomers follows logically, while the amorphous substance which always accompanies the tertiary amine is seen to be probably the polymeric benzylene-imide.

It is hoped to publish fuller details of this work later.

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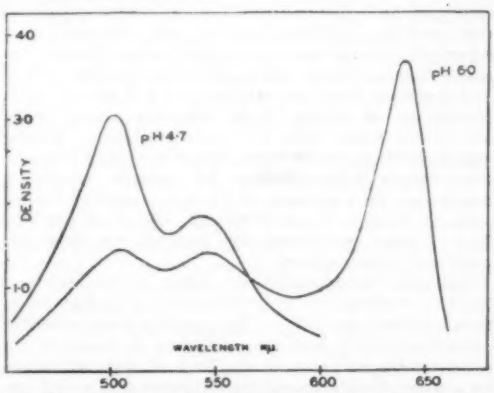
Use of Dyes to Determine the Iso-electric Point of Gelatin

The effect of small concentrations of gelatin on the absorption characteristics of aqueous solutions of certain carbocyanine dyes has been reported by Sheppard[1] and Solovyev[2].

During an investigation of some of the factors influencing the adsorption of these dyes to proteins, it was noted that the adsorption is electrostatic in character and depends upon the *p*H of the gelatin solution. Certain dyes exhibit a narrow and intense absorption band in the red region of the spectrum in dilute gelatin solutions (0·01 per cent) if the *p*H is above the iso-electric point. Below the iso-electric point the absorption is similar to that of the aqueous dye solution. The colour change is sharp and is illustrated by the absorption curves in the accompanying diagram.



The absorption of 1 : 50,000 3 : 3′-dimethyl 5 : 5′-dichloro-9-ethyl thiacarbocyanine chloride in 0·01 per cent aqueous gelatin solution at two *p*H values

This effect provides a quick and convenient method for the determination of the iso-electric point of gelatin. The following technique has been found to give reliable and reproducible results. Several dyes were examined and the one selected was chosen for sharpness of end-point.

To 50 ml. distilled water add 0·5 c.c. of 1 per cent gelatin solution followed by 0·5 c.c. of 1 : 2,000 ethyl alcohol solution of 3 : 3′-dimethyl 5 : 5′-dichloro-9-ethyl thiacarbocyanine chloride. If, as usual, the *p*H of the solution is above the iso-electric point, the colour will be blue. *N*/100 hydrochloric acid is added from a micro-burette until the colour of the solution changes from blue to red. Each addition of acid is followed by thorough stirring of the solution. The end-point is reached when the last trace of blue colour just disappears from the solution. Measurement of the *p*H of the solution at this stage gives the iso-electric point. If the end-point is overshot, addition of a slight excess of alkali will enable the titration to be repeated, and by this method several estimations can be made on one sample.

A comparison of the dye method with the spirit precipitation method[2] is given in the following table, using four different gelatins. The figure given for the dye method is the mean of four estimations.

Gelatin	Iso-electric point	
	Dye	Spirit precipitation
A	*p*H 5·05	*p*H 4·95
B	4·75	4·75
C	4·87	4·85
D	5·05	5·05

The end-point with acid-washed gelatins of high iso-electric point (*c.* 8·0) is not so sharp, but with these gelatins the spirit precipitation method also gives indeterminate results. The dye method has the advantage that an estimation can be made on as little as 5 mgm. of the gelatin.

Thanks are due to the directors of Ilford Limited, for permission to publish this note.

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Sept. 20.

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Inhibition of the Low-Temperature Polymerization of *iso*Butene

R. M. Thomas *et al.*[1] have stated that the presence of olefines diminishes the yield of the low-temperature polymerization of *iso*butene by Friedel–Crafts catalysts and also reduces the molecular weight of the product. Plesch, Polanyi and Skinner[2] have reported that ethanol or diethyl ether inhibit the same reaction when using titanium chloride ($TiCl_4$) and traces of water as catalyst, even if the titanium chloride is in excess of the inhibitor; and Plesch[3] has shown acetic acid to be an inhibitor. Norrish and Russell[4] have reported that the rate of the low-temperature polymerization by stannic chloride is decreased by ethanol, *t*-butanol, diethyl ether, acetone, butene-1 and butene-2, and that the first four of these substances also reduced the molecular weight of the product.

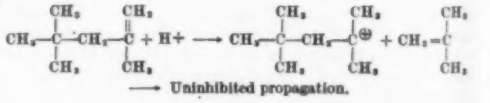
We have investigated the effect of inhibitors on the low-temperature polymerization of *iso*butene by boron trifluoride (BF_3). The reactions were carried out adiabatically and were followed in terms of the temperature rise, due to the heat of polymerization, by means of a thermocouple. The reaction vessel was part of a vacuum system, and the required volume (50 ml.) of monomer solution in hexane (10 per cent vol./vol.) could be syphoned into it from the reservoir with complete exclusion of the atmosphere. The inhibitor was added by condensing into the reaction vessel a known quantity of the inhibitor vapour. When the mixture of solvent, monomer and inhibitor had been brought to a temperature near $-65°$ C., the reaction was started by circulating a fixed volume of boron trifluoride and nitrogen (containing $7·5 \times 10^{-3}$ gm. mol. BF_3) continuously through the solution. This circulation was carried out by an all-glass magnetically operated pump working in a closed circuit.

The mean molecular weights of the polymers were calculated from the intrinsic viscosities of their solutions using the Houwink equation[5] and the constants determined by Florey[6]. The yields were measured both by estimating the bromine consumed by the residual monomer and by weighing the polymer precipitated in alcohol and dried.

The yield of polymer was high (88–100 per cent) and not affected by the inhibitors used. In the absence of inhibitor, the reaction-rate decreased monotonically from its initial maximum value, the temperature rise (24–27° C.) was completed in 35–45 sec., and a product of molecular weight 40,500–55,000 was obtained. The presence of *t*-butanol and ether produced markedly *S*-shaped time–temperature curves analogous to those observed in free-radical polymerizations and possibly having a similar explanation[7].

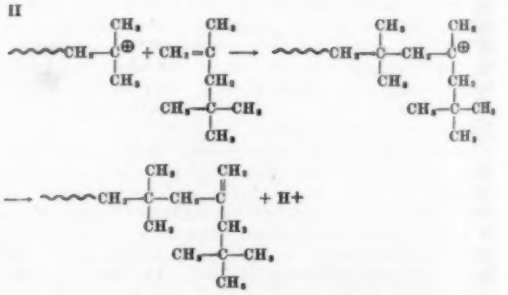
With 3×10^{-3} gm. mol. *t*-butanol or ether present, the time of reaction increased to 160 and 200 sec. respectively, and in the case of *t*-butanol gave molecular weights of polymer of 11,100–13,700. The addition of the same quantity of di-*iso*butene (a mixture of 2,4,4-trimethyl pentene-1 and -2) reduced the molecular weight to 5,600 but left the reaction time at 40 sec., as in the uninhibited experiments. Thus *t*-butanol and di-*iso*butene both increase the rate of chain termination; but *t*-butanol reduces the rate of chain initiation (by complex formation with boron trifluoride), and di-*iso*butene leaves this rate unaffected. A possible explanation of the di-*iso*butene case in terms of the carbonium ion theory of Friedel–Crafts polymerizations[8,9] and the steric properties of the structures involved is that an activated di-*iso*butene molecule may start a chain (I), but the incorporation of di-*iso*butene in a growing

I



⟶ Uninhibited propagation.

II



Further propagation sterically inhibited by neopentyl group.

chain (II) terminates the latter due to the steric hindrance to any further step[9,10].

The terminated chain in II can start another chain by proton transfer, thus permitting an original initiation process to cause the same total amount of polymerization with and without di-*iso*butene but giving lower molecular weights in its presence.

We are informed by A. G. Evans and G. W. Meadows that they have established the occurrence of a high degree of chain transfer for the reaction of *iso*butene in the presence of boron trifluoride–ecatalyst complexes. Their results have been submitted for publication elsewhere[11].

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Streaming Potential in Paper Chromatography

The net resultant flow of solvent through the capillary channels of paper used in chromatography is in a direction away from the point of feed, and it was therefore considered possible that such a system might result in the setting up of a streaming potential[1].

This has been verified experimentally in some cases, using water and inorganic salt solutions: distilled water flowing through a washed and dried strip of No. 3 Whatman paper showed a potential gradient of approximately 10 mV. per cm. measured by a Cambridge *p*H meter. With 1 per cent thorium nitrate solution in place of water, the potential was reduced almost to zero. 1 per cent sodium chloride solution showed a potential gradient of approximately 4 mV. per cm. Various factors, such as rate of flow of liquid, and nature of electrodes used in making the measurements, may affect the values considerably.

Such potentials (or their causes) may well exert a marked effect on the process of chromatographic development, and preliminary experiments in which the potentials have varied have given interesting indications. For example, development of 0·01 ml. of 0·1 per cent aqueous solution of a mixed colour (Edicol Green 37113, I.C.I., Ltd.) with distilled water failed to separate the components, the band moving with the solvent front, whereas development with 1 per cent sodium chloride solution achieved complete separation into blue and yellow bands. Very dilute solutions of aluminium chloride and thorium nitrate caused strong adsorption of both components, which is difficult to attribute to 'salting out' effects[2] in view of the low salt concentrations, and more probably relates to changes in the electric double layer.

Indications have been observed using either the strip or central feed technique[3] that the flow of one liquid over another occurring in 'partition' chromatography may result in streaming potentials of varying sign, which may be significant in considering possible mechanisms of 'partition' separations.

A study of the above and related phenomena is in progress and will be reported more fully elsewhere.

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Dielectric Properties of the Human Body in the Microwave Region of the Spectrum

As a preliminary to a detailed study of the reactions of certain body tissues to electromagnetic radiations on centimetre wave-lengths, it has been found desirable to determine the propagation characteristics of such waves in various parts of the body.

The specimens were obtained in most cases from surgical operations, being selected for homogeneity and cut into sections suitable for insertion in a waveguide cell. In this cell the specimen was trapped between a tight-fitting plug of polystyrene one half wave-length in thickness and a reflecting metal plunger driven on a micrometer screw thread. The cell was surrounded by a bath of water thermostatically controlled at a temperature of 37° C. to an accuracy of $\pm \frac{1}{2}$° C.

From measurements on the standing wave pattern set up in the wave-guide feeding the cell, two constants α and β for the medium were determined by a method similar to that used by Roberts and von Hippel[1]. The parameter α is the absorption coefficient and is expressed in nepers/cm. The parameter β is the phase constant expressed in radians/cm. and is a measure of the velocity of the wave in the medium. To a first approximation the dielectric constant of the medium can be taken as proportional to β^2.

The following representative body constituents have been measured in this way at a wave-length of 3 cm., several thicknesses from various specimens being used where practicable (Table 1).

The results quoted in Table 1 should have a measurement accuracy better than $\pm$ 5 per cent in α and $\pm$ 1 per cent in β; but the difficulty of repeating biological specimens accurately should be appreciated. Measured in the same equipment, the corresponding constants for distilled water at 37° C. were $\alpha = 2{\cdot}70$ and $\beta = 16{\cdot}0$, which are in good agreement with those obtained by Collie, Hasted and Ritson[2].

Examination of the results for biological materials leads to the following general conclusions.

(1) The absorption coefficients at 3·18-cm. wave-length for a large number of body constituents are substantially the same as that of water at the same temperature. Fatty tissue and bone have a considerably lower absorption, and are relatively transparent to the radiation.

(2) The phase constants for a large number of body constituents fall into a group with a rather lower average value than that of water. Small, but significant, differences occur within the group, presumably attributable to the variation of water content. This is demonstrated by results taken on

Table 1

Specimen	α (nepers/cm.)	β (radians/cm.)	Remarks
A. Normal			
Whole blood	2·90	13·5	Uncoagulated by 1/500 mgm. heparin
Skin 1. Breast	2·65	12·1	Free of areolar tissue
2. Leg	2·55	11·8	
Muscle (skeletal)	2·50	11·7	Stripped of fascial sheath
	2·70	11·6	
Sigmoid colon	2·75	13·5	Sections included muscle coats, but no serous coat
	2·70	13·4	
Tænia coli	2·85	13·6	
Thyroid gland	2·70	13·7	Hyperplastic
	2·85	13·5	
	2·65	13·5	
Prostate gland	2·70	13·7	Hyperplastic
	2·50	13·7	
Fat 1. Breast	0·49	4·0	Free of areolar tissue
2. Leg	0·44	4·0	
Bone (femur)	0·56	5·4	Specimens obtained from a post-mortem examination. Bone machined accurately to fit wave-guide
	0·56	5·4	
Bone marrow	0·79	5·1	
B. Malignant			
Carcinoma of breast (scirrhus)			
(*a*)	2·70	13·1	Sections were taken from four different tumours and all were confirmed scirrhus carcinoma of breast by histological examination. The only difference revealed was in the degree of fibrous stroma present in each tumour section
	2·75	12·5	
(*b*)	3·0	13·1	
	3·2	13·0	
(*c*)	2·75	12·5	
(*d*)	2·65	12·5	

Table 2

Specimen	Corpuscle concentration ($\times 10^6$ per c.mm.)	Radians/cm.	Dielectric constant relative to air
Blood serum	—	15·2	57
Whole blood	4·9	13·5	45
Corpuscles in high concentrations	17·1	12·7	40

whole blood and its products after centrifuging (Table 2).

Fatty tissue and bone have correspondingly lower dielectric constants, of the order of 4·5 and 8·0, respectively.

(3) At this wave-length no significant difference may be expected in the behaviour towards the radiation of malignant and non-malignant tissue. It is to be expected that the effect of the polar water molecules will overshadow any changes which may result from biologically different structures.

Consider 3-cm. wave-length radiation falling normally from outside on an area of the body, which can be treated for this purpose as a uniform and infinitely extended medium with average values of the constants α and β. Calculation shows that approximately one-third of the incident power will be absorbed by the body, the remainder being reflected. The high value of the absorption coefficient indicates that the majority of the absorbed power will be dissipated initially in the first few millimetres of skin. The resulting heat distribution will normally be modified by conduction and by the action of the vascular system.

These dielectric measurements are being extended to 10-cm. and 1·25-cm. wave-lengths.

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Wound Extracts and their Effects on the Growth of Hen Fibroblasts

Sterile, healing wounds (rats) were extracted with physiological salt solution. Extracts were made from wounds of ages from 1 to 12 days. The extract was dialysed with several changes of distilled water at a low temperature in a 'Cellophane' tube. In this way the albumin and globulin fractions of the extracts could be separated. Both solutions were then brought to *p*H 6·5–7 and diluted to the same dry-weight concentration. The usual heart fibroblast cultures in Carrel flasks and Carrel glasses were later treated with the prepared extracts. The results are given in Fig. 1, in which the zero horizontal line represents the usual index of increase for the corresponding control culture. A minus index means growth inhibition, and a plus index represents increase of growth.

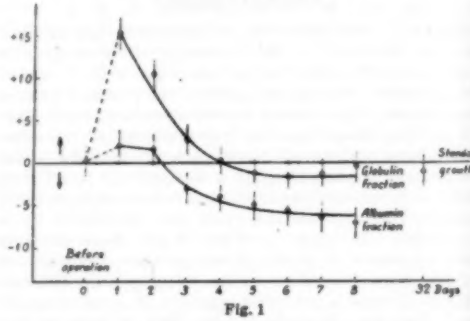
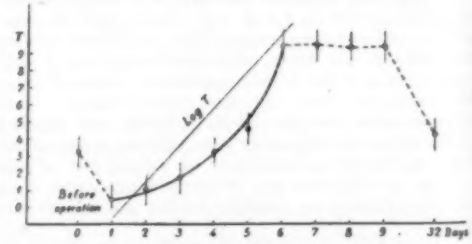


Fig. 1

The power of the wound to combine with basic dyestuff was also investigated. By a previously developed method (Balazs) the amount of dyestuff that the tissue bound was quantitatively ascertained. Frozen sections of wound preparations (100 μ) were later weighed and laid in a specific concentration of toluidine blue in water solution. The preparation



$T = 10^{-4}$ mgm. dyestuff per mgm. tissue

Fig. 2

remained in this solution for 24 hours at + 3° C. Then the concentration of the coloured solution was ascertained photometrically, and from the figures obtained the amount of dyestuff absorbed per mgm. tissue was calculated. The results are given in Fig. 2.

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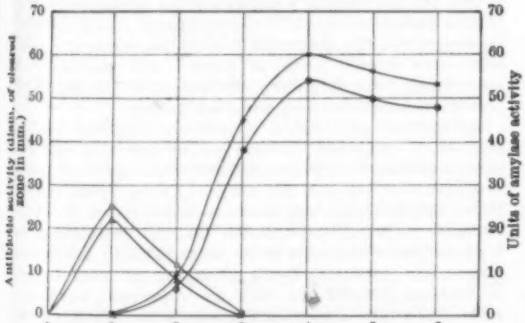
Antibiotic Activity as Shown by a Highly Amylolytic Strain of *Bacillus subtilis*

In the course of an investigation on the formation of amylase by *Bacillus subtilis*, it was observed that the organism, when grown on wheat bran medium, showed a pronounced antibiotic activity. The maximum activity was found in the aqueous extract from a 24-hour-old culture. The amylase formation during this period was found to be low, but steadily increased with further incubation. This phenomenon led to a study of the relationship between the antibiotic production and amylase formation by *B. subtilis*[1] (N.C.T.C. : 2027 *N*) when grown on wheat bran.

The production of substances of antibiotic nature by *B. subtilis* has been studied by earlier workers. It has been shown that three compounds, bacillin, subtilin and bactracin, which are characterized by their bacteriostatic and lytic actions on different Gram-positive and Gram-negative organisms, are synthesized by the various strains of *Bacillus subtilis*. Recently, work has been conducted employing wheat bran as a whole or wheat bran extracts for culturing *P. notatum*[2,3]. These observations indicate the possibility of increasing the penicillin yield by about 60 per cent. It has been suggested that as wheat bran has a fairly high fat content, the fatty acids liberated during the growth of fat-splitting organisms are responsible for the antibiotic action. No direct proof has, however, been advanced to demonstrate the origin of the antibiotic substances from fatty acids.

Bacillus subtilis was grown on wheat bran (10 parts) moistened with the phosphate buffer solution (pH 7·0; 25 parts) for the production of amylase[4]. A control series using de-fatted wheat bran was also run along with the experimental series. The extracts were made with water (25 parts) at intervals of every 24 hours. The mass was then strained through cheese cloth and the extract filtered through Whatman's filter paper No. 42. The amylase and antibiotic activities of the clear filtrates were then determined. The antibiotic activity was tested against *Staphylococcus aureus*, by the cup assay method[5]. The results obtained are given in the accompanying table.

Age of the culture (days)	Amylase activity (units per ml.)		Antibiotic activity (diameter of the zones in mm.)	
	Whole wheat bran	De-fatted wheat bran	Whole wheat bran	De-fatted wheat bran
1	Negligible	Negligible	25·0	22·0
2	9·0	6·5	11·0	8·0
3	45·0	38·0	Negligible	Negligible
4	60·0	54·5	,,	,,
5	55·5	50·0	,,	,,
6	53·0	48·0	,,	,,



Amylase and antibiotic activity of *B. subtilis*. ×—×—, ○—○—, wheat bran whole; ⊕—⊕—, △—△—, wheat bran de-fatted

The results show that an active strain of *B. subtilis* is able to synthesize antibiotic substances during the earlier stages leading to the production of amylase. This antibiotic activity cannot be attributed to the liberation of fatty acids, because the activity is developed even on de-fatted bran.

The antibiotic activity is at a maximum on the first day of growth and gradually disappears with extended incubation. On the other hand, amylase production, which is negligible on the first day, steadily increases as the incubation period proceeds, and reaches its peak value on the fourth day. These observations show that there is some relationship between the production of antibiotic substances on one hand and amylase formation on the other. Probably the secretion of antibiotic substance at an earlier stage serves to prevent invasion by undesirable organisms. In the light of the observations already made by Rao and Murti[6], the lag phase in amylase formation may bear some relation to the development of antibiotic substances. Further work in this direction is in progress.

My thanks are due to Prof. V. Subrahmanyan for his interest and guidance.

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Origin of the Radio Frequency Emission and Cosmic Radiation in the Milky Way

Recent measurements by Hey, Parsons and Phillips[1] on the angular distribution of the galactic radio-frequency radiation at 64 Mc./s. and particularly the observations by these authors, by Bolton and Stanley[2,3] and by Ryle and Smith[4] on variable sources of radio-frequency radiation in low and high galactic latitudes strongly suggest a revision of current ideas on the origin of this radiation.

The interpretation of galactic radio-frequency radiation by free-free transitions of electrons in the interstellar gas, as advanced by Reber, Henyey and Keenan[5] and also adopted by myself[6], besides being obviously unable to explain the variable radiations now meets with the following difficulties :

(*a*) The explanation of the intensity and angular distribution at 20–30 Mc./s. requires the assumption of an electron temperature of 100,000–200,000° K., as Townes[7] and the present author[4b] noticed independently. On the other hand, we know that even in planetary nebulæ with central stars of more than a hundred thousand degrees, the temperature of electrons is kept as low as approximately 10,000° by collisions with oxygen. (*b*) The observed 'concentration' of the radiation in galactic latitude is too small, that towards the galactic centre too strong.

Let us now examine the assumption—which hitherto has mostly been rejected—that the galactic radio-frequency radiation originates in some particular type of stars. Comparing the 'radio-isophotes'[1] of the galaxy with the visual ones of Hopmann[8]—taking roughly into account the obscuration by dark nebulæ—we find that an *average* mag. 1 star (visual scale) emits about 2×10^{-23} watts per m.^{2} per c./s. (afterwards simply called a 'unit').

The discrete sources[1,2,3] emitting 6×10^{-23} (Cygnus) to 2×10^{-24} (Hercules) units cannot, so far, be identified with any reasonable objects on Bottlinger's Galactic Atlas; these should therefore be fainter than mag. 6. For them, therefore, a mag. 1 object would emit *more* than 6×10^{-21} to 2×10^{-22} units. On the other hand, the sun (mag. -27, visual) emits approximately 13×10^{-23} units—taking the 'quiet' radiation with an effective temperature of $1{\cdot}5 \times 10^4$ degrees; slight perturbations are sufficient to increase this figure by several powers of ten. Using the first 'standard' figure, we obtain for a mag. 1 star approximately 8×10^{-24} units.

It seems at first quite incredible that the ratio of 64 Mc./s. radiation to visual light should be $2{\cdot}5 \times 10^{19}$ times higher for an average star and probably more than 10^{23} times higher for some of the discrete sources than it is for the sun. In reality, however, there is nothing impossible about the idea that the sun is an extremely weak radio-frequency radiator.

During the great solar eruption of July 25, 1946, according to Lovell and Banwell[9] the radiation on 72 Mc./s. increased temporarily to an effective temperature of 8×10^{11} °K., that is, by a factor of $5{\cdot}3 \times 10^8$ compared with our adopted 'normal' value. Considering, moreover, that the area of the eruption observed by Ellison[10] in $H\alpha$ was only 1/800 of the visible hemisphere, and that for a star with a surface temperature of 3,000°, for example, the surface area per unit visual light is about ninety times larger than for the sun, a total extra-factor of 4×10^{10}, or even somewhat more for a star with strong eruption-activity, appears quite possible.

The low galactic concentration of radio-frequency emission[1] indicates that it originates not in the high-temperature *O* and *B* stars showing high concentration towards the galactic plane, but in late-type stars, probably connected with Baade's population II. This hypothesis is favoured by the strong radio-frequency radiation of the galactic nucleus consisting of population II stars[11]. In addition, it should be noted that the spectra of many late-type stars exhibit indication of an 'activity' much superior to that of the sun, that is, strong emissions within the Ca^+, H and K absorption lines; broad hydrogen emissions superposed by metallic absorption lines as in solar eruptions[12], etc. Since even large solar eruptions give very little change of visual light, we should not expect necessarily to find great visual light variations in objects emitting a changing radio-frequency radiation.

Some difficulty might be derived from the fact that the frequency distribution of the galactic radiation is somewhat different from that of the sun. However, observations by Allen[13] on the angular distribution of the sunspot-radiation at 200 Mc./s. (derived from Fig. 4, ref. 13) indicate that this is emitted at a radio-optical depth of approximately 4. Quite plausible differences among the absorbing layers of different types of stars thus appear amply sufficient to account for the observed differences of the radio-spectra.

Our hypothesis of the great abundance of stars the radio-frequency emission of which is roughly 10^{11} times higher than that of the sun gains increased interest in connexion with Forbush's[14] and Ehmert's[15] discovery of cosmic radiation emitted by solar flares. For the strong eruption of July 25, 1946, Forbush—measuring two-hourly means—observed an increase of cosmic radiation by 15 per cent. Let us compare now the 64-Mc./s. radiation for this eruption of about 5×10^{-20} (to 5×10^{-19}) units with that of the whole sky. Using the 'isophotes' given by Hey, Parsons and Philips[1], I get an average intensity of roughly 5×10^{-21} units per unit solid angle, or $6{\cdot}3 \times 10^{-20}$ units altogether. Thus the ratio of eruption-radiation to everyday radiation is almost the same for the 64-Mc./s. radio-frequency radiation and for the cosmic radiation primarily consisting of charged particles.

Taking the average over 3·2 years, Ehmert's coincidence-counting indicates a solar contribution of 0·07 per cent to the cosmic radiation, a figure which for various reasons might be increased somewhat. Taking the average radio-frequency radiation of the sun to be ten times this normal, that is, $1{\cdot}3 \times 10^{-21}$ units, this is about 2 per cent of the radiation of all the galaxy. Again, the idea of a general proportionality between cosmic radiation and radio-frequency radiation is confirmed.

Since the cosmic radiation undergoes considerable changes within the uppermost few cm. of mercury pressure of our atmosphere, we must in any case assume that it originates in the tenuous outer parts of some cosmic structures. The hypothesis of its origin in supernovæ would lead us to expect a great increase of cosmic radiation in connexion at least with every galactic supernova. In fact, an eruption like that of Tycho's nova in 1572, which at maximum was about 400,000 times brighter than most extra-galactic supernovæ, should have increased the cosmic radiation so much as to produce great biological effects which could not have been overlooked.

On the other hand, within the frame of our hypothesis, the problem of a sidereal time variation of the cosmic radiation should be investigated more closely. In any event, the magnetic field of the earth and perhaps also cosmic fields of force[16] will smooth out considerably the angular distribution of the primary cosmic radiation coming from the galaxy.

Altogether our central hypothesis that the radio-frequency radiation of the galaxy as well as the cosmic radiation originate in (late type) stars showing eruption-activity like the sun, only roughly on a 10^{11} times larger scale, has much to recommend it. The detailed physical mechanisms for the production of both radiations remain to be investigated; no doubt large-scale magnetic fields changing in vast layers of tenuous ionized gas play an important part (see refs. 17, 18, 19). Applying Faraday's law of induction, it is evident[18] that changing solar magnetic fields can at most produce 10^9–10^{10} eV. The observation of energies up to 10^{15} eV. points toward the existence

of much larger spots, etc., in stars in agreement wit h our previous assumptions.

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Maintenance of Nocturnal Ionization

THE rate of change of ionization in the F_2 ionospheric layer is considered to follow the equation

$$dn/dt = q(t) - \alpha n^2, \qquad (1)$$

under the assumption that the layer is electrostatically neutral and that the net rate of attachment[1,2] is negligible. In (1), n is the number of electrons/cm.^{3}, α is the coefficient of recombination (cm.^{3}/sec.) and $q(t)$ is Chapman's ionization function[3]. During darkness $q(t) = 0$; whence upon integration equation (1) becomes

$$1/n = \alpha t + C_1. \qquad (2)$$

It is well established that during the absence of solar radiation the decrease in ionic concentration does not follow equation (2) exactly. In an effort to provide a better explanation of the nocturnal concentration of ions in the F_2-region, the following theory was developed.

A diurnal temperature variation is assumed to exist at the height of the F_2-layer such that

$T = T_m$, from 2 hours after sunrise to 2 hours before sunset;
$T = T_m \exp(-2ft)$, from 2 hours before sunset to sunrise;
$T = \varphi(t)$, from sunrise to 2 hours after sunrise. (3)

These assumptions are consistent with the theory of radiative equilibrium put forward by Godfrey and Price[4], and other workers in this field. The constant f may be easily evaluated employing $T = T_0$ at sunrise, and t as the time elapsing between the occurrence of T_m and T_0.

From relationship (3) it is easily ascertained that the corresponding pressure function as evaluated from the hypsometeric equation is given by

$$P = P_m \exp(-2f(g+1)t, \qquad (4)$$

where g is a constant empirically determined. The value P_m is that computed when $T = T_m$.

Obviously, under the assumed nocturnal temperature decrease, an atmospheric contraction occurs at the level of the F-layer. We make the logical assumption that the influx of electrons/cm.^{2} is proportional to the influx of total particles/cm.^{2}.

Now define an 'influx function'

$$s(t) = (n/N)\, dN/dt, \qquad (5)$$

which governs the increase in ionic concentration brought about by atmospheric contractive effects. N is the total number of original particles/cm.^{3}.

Under the above conditions, the equation for the rate of change of ionization during the absence of solar radiation becomes (neglecting meteoritic and other possible ion sources)

$$dn/dt = s(t) - \alpha n^2. \qquad (6)$$

It is further recalled that under conditions of volume recombination such as exist in the ionosphere, it is possible to write[5]

$$\alpha = aT^{1/2} = aT_m^{1/2} \exp(-ft), \qquad (7)$$

where T is the electron temperature (° K.). It is permissible to employ equation (7) if it is assumed that the velocity distribution of the electrons, ions, and other particles follows a Boltzmann distribution, and that all particles are in thermal equilibrium.

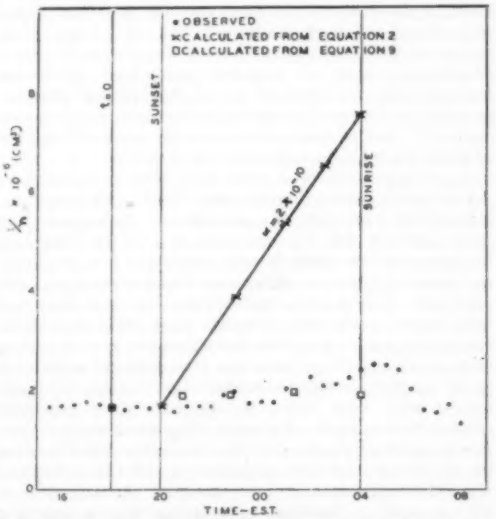
The complete recombination equation during darkness, taking cognizance of the dependence of the recombination coefficient on temperature, thus becomes

$$dn/dt = (n/N)\, dN/dt - \alpha_0 n^2 \exp(-ft), \qquad (8)$$

where $\alpha_0 = aT_m^{1/2}$. The above equation on simple quadrature becomes

$$1/n = \{\alpha_0/2f(g+\tfrac{1}{2})\}\{1 - \exp(-ft)\} + C_2. \qquad (9)$$

The accompanying figure shows $1/n$ versus time (Eastern Standard Time) for one day in August 1947 at Washington, D.C.[6]. The value of n was computed from the familiar expression $n = Kf^2$ for each half-hour interval. Upon the graph is indicated the decrease of electron concentration expected from equation (2), and that anticipated by employing equation (9). It is evident that the rate of change of electron population is very much better described



Comparison of $1/n$ determined from experimental evidence, from $1/n = \alpha t + C_1$ and from $1/n = \{\alpha_0/2f(g+1)\}\{1 - \exp(-ft)\} + C_2$. (August 1947. F_2-region ionization)

by the latter relationship, which contains the influx term, than by the former.

Since the temperature at the height of the *E*-layer was considered to have a negligible diurnal temperature variation, the relationships derived above degenerate to the conditions usually assumed for the *E*-ionospheric layer.

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Uncertainty Principle

Writers appear either to introduce or to illustrate the uncertainty principle by supposing that a fundamental particle such as an electron is viewed through a microscope to determine its position at the same time as measurement is being made of its momentum[1]. The error in the position of the particle is accepted to be δx in the formula for the resolution power of a microscope, namely, $\delta x \sim \lambda/\sin\theta$. This formula is derived in optics from a study of the diffraction of light from two equal disks placed close together and from one disk alone.

Now the diffraction ring patterns of the disks are brought about, according to the quantum theory itself, by the action of quanta in the mass, and each individual quantum merely energizes a particular spot in a pattern. I cannot see that the optics formula, which essentially gives the effect of the mass action, can be applied to the action of an isolated quantum or photon. The appearance of a single photon on a screen cannot furnish any information about the direction from which it came before striking the screen, and even less can it indicate the point from which it emanated. If, as we are told, the wave phenomenon of light is due to mass action of photons, then we require proof that the wave formula can be applied to an individual photon, because we know that the behaviour of a single molecule of a gas is different from the mass behaviour of molecules producing sound in a gas.

A second difficulty is that the optics formula does not so much give a fundamental limit to observation, but rather a formula of convenience. It implies that it is difficult for the unaided eye to differentiate between the two sets of ring patterns, but it makes no claim that no difference exists between the patterns. The analysis admits that the set from one disk alone is circular, whereas that from two disks close together is oval. The formula gives the condition that the inner rings from the two disks change over from dumb-bell shapes which can readily be associated with two disks, to approximately elliptical ovals which cannot. By employing accurate methods for measuring shape and the intensity distributions in the fields, we can proceed considerably beyond the limit represented by the formula. An astronomer, for example, is justified in deducing that a star is a double star if the ring pattern he obtains from it is oval.

Perhaps the quantum theory can put this matter right, but I find the classical arguments so full of gaps that they are far from convincing.

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[1] For example, Gurney, "Elementary Quantum Mechanics", p. 49. Dustman, "Elements of Quantum Mechanics", p. 12. Heisenberg, "The Physical Principles of the Quantum Theory", p. 15 (German).

Early Man and Fossil Vertebrates on the Island of Celebes

Outside Java, which has yielded many important finds of fossil remains from the *Pithecanthropus* group of mankind and an abundance of fossil vertebrates, as well as two distinct palæolithic industries (the Patjitan chopper chopping-tool complex with an intrusion of 7 per cent Acheul hand-axes, and the Sangiran flake industry), palæolithic finds have not hitherto been made in the Indonesian Archipelago.

Prehistorical research on Celebes has now shown, however, that early man inhabited this island in Pleistocene times, since palæolithic tools have been discovered, associated with fossil bones of vertebrates of Asiatic origin. The newly discovered site is situated in the southern part of the island near Tjabenge and is bordered by the Walanae River on one side and by the Great Sinkang depression on the other.

Dr. D. A. Hooijer, of the Rijksmuseum van Natuurlijke Historie at Leyden, has studied the fossil fauna and has distinguished among the small collection five different forms, of which three are extinct: (1) a new genus of a large pig, *Celebochœrus heekereni* Hooijer[1]; (2) a dwarf archidiskodont elephant which is very closely related to the Lower Pleistocene *Archidiskodon planifrons* (F. and C.) from India and China[2]; (3) a large tortoise, *Testudo margæ* Hooijer[3]. The other two fossils are *Anoa depressicornis* (Smith) subsp. and *Babyrousa babyrussa beruensis* Hooijer[4], which are two typical elements from the recent fauna of Celebes, thus proving that those mammals had already evolved in Pleistocene times.

Celebes was, perhaps, never connected with Java (and Borneo), as the islands are separated by the deep Strait of Macassar and the Flores Sea. This is the so-called 'Wallace's Line', which indicates a faunal break between the Indo-Malayan and the Australian fauna (1860). This theory was at first generally accepted by zoologists; but now it is known that 'Wallace's Line', which was geologically well founded, separates a zone with rich animal life from a badly impoverished one, as Ernst Mayr has rightly pointed out. Migration to Celebes took place via land-bridges, which connected this island with the Philippines, Formosa and southern China. The newly discovered palæolithic industry is very closely related to the Sangiran flake industry.

Systematic research in this part of Celebes will no doubt lead to other important finds.

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[4] *Proc. Kon. Ned. Akad. Wet. Amsterdam*, **51**, 1322 (1948).

INTERNATIONAL RADIO CONFERENCES

DURING the summer of 1948 there were a number of international meetings in Europe on various aspects of radio research, development and operation. Three of these were held in Stockholm during July, while some of the others took place in Brussels, Copenhagen and London (see *Nature*, **161**, 695; 1948).

The International Scientific Radio Union (U.R.S.I.) held its Eighth General Assembly in Stockholm during July 13–24. Beginning concurrently with this meeting, the Fifth Reunion of the International Consultative Committee on Radiocommunication (C.C.I.R.) was also held in Stockholm. On the termination of the U.R.S.I., a brief meeting of the Joint Commission on Radio-Meteorology was held in the same place. Later, in Brussels, during July 28–30, there was a meeting of the Mixed Commission on the Ionosphere. At all these meetings the subjects discussed included various scientific and technical matters on which international collaboration or agreement is necessary in order to advance our knowledge of radio science and its application to radio communication, broadcasting and navigation. The above meetings were followed by a British Commonwealth Specialist Conference on Radio Research held in London during August 4–6. This formed a very convenient occasion to review the various recommendations made by the international assemblies, and to agree on an appropriate distribution of responsibility, within the Commonwealth, of the British contribution to the international research programme.

Wave-lengths for Broadcasting

Reference has already been made in *Nature* (**162**, 562; 1948) to the European Broadcasting Conference in Copenhagen, where over a period of some ten weeks a new plan was produced for a revised allocation of wave-lengths to broadcasting stations in Europe. The Copenhagen plan, 1948, as it is called, will come into operation on March 15, 1950, when some 340 stations and synchronized networks will be accommodated in 139 channels in the long (frequencies 150–285 kc./s.) and medium (525–1,605 kc./s.) wave portions of the radio spectrum allotted exclusively for broadcasting. Details of the new wave-lengths, with the frequency and power assigned to each station, are given in the *Wireless World* of November 1948.

Resolutions of the U.R.S.I. and C.C.I.R.

Reverting to the two major conferences, which are concerned with scientific research and development, some brief details of the resolutions and recommendations of the U.R.S.I. and C.C.I.R. are given below. The International Scientific Radio Union, the president of which is Sir Edward Appleton, after considering the extension of the radio field, decided to replace the four commissions, into which it was previously organised, by seven commissions. The titles and presidents of these are as follows: (I) Measurements and Standardization, Dr. J. H. Dellinger (U.S.A.); (II) Troposphere and Wave Propagation, Dr. C. R. Burrows (U.S.A.); (III) Ionosphere and Wave Propagation, Sir Edward Appleton (Great Britain); (IV) Terrestrial Atmospherics, Prof. H. Norinder (Sweden); (V) Extra-terrestrial Radio Noise, Dr. D. F. Martyn (Australia); (VI) Waves and Oscillations, Prof. B. van der Pol (Netherlands); (VII) Electronics, Dr. G. Lehmann (France).

The C.C.I.R. conference was held under the presidency of Dr. H. Sterky, director-general of telegraphs in Sweden, and was attended by delegates from more than thirty nations. A large proportion of its work at Stockholm consisted in surveying a number of technical questions put forward by the Atlantic City meeting of the International Telecommunications Union. Only a preliminary examination of these subjects could be carried out in most cases; and at the termination of the meeting, the plenary assembly of the C.C.I.R. set up thirteen international study groups to carry out preparatory surveys and submit reports for the next reunion, which is to take place in 1951. The subjects for study included various aspects of radio transmitters and receivers, wave propagation along the ground and through the lower and upper atmosphere, time signals and standard frequencies, and certain questions relating to broadcasting and television. During the Stockholm meetings, recommendations were made that Prof. B. van der Pol, of the Netherlands, should be appointed director, and Mr. L. W. Hayes, of the British Broadcasting Corporation, vice-director of the C.C.I.R. Both appointments were to be taken up in January 1949.

Some of the conclusions and resolutions on scientific matters reached by the various conferences are referred to briefly in the following sections.

Radio Standards and Measurements

It was strongly recommended by the U.R.S.I. and the C.C.I.R. that the study of field-strength measurement over the whole frequency spectrum should be continued, and that the interchange of equipment between the various national laboratories should be encouraged. In addition, the U.R.S.I. urged that a study of standard noise sources of various types should be carried out, and that investigations should be made of the various methods of measuring radio-frequency power, particularly at frequencies above a few hundred megacycles per second.

On the question of standard frequency transmissions, the C.C.I.R. stated that there is an urgent need to put into operation additional standard frequency and time stations, perhaps in the United Kingdom and in Australia, to serve the now inadequately served areas of the world. Such stations should operate on the frequencies assigned for the purpose at the Atlantic City Conference in 1947, and it was recommended that an international study group should organise and control experiments to determine the effective service areas and the zones of interference with the existing emissions from Washington (Station *WWV*).

The Commonwealth Conference urged that the plans for the establishment of a standard frequency service in the United Kingdom should be pursued, and that both Australia and South Africa should establish similar services, if possible.

A further recommendation of some interest is that all standard-frequency stations should periodically

and simultaneously interrupt their transmissions to permit measurement of natural radio noise, suitable programmes for this purpose to be worked out jointly by the U.R.S.I. and C.C.I.R.

Radio Wave Propagation

The subject of wave propagation was of common interest to all the international bodies, although perhaps with different objects in view; the following recommendations may therefore be taken as being agreed generally by the various organisations concerned.

(*a*) *Propagation through the ionosphere.* In order to assist the study of the characteristics of the ionosphere, and the presentation of the results of ionospheric soundings, a detailed list of symbols and related nomenclature was drawn up and recommended for general adoption. Various details in the technique of carrying out vertical incidence soundings were revised in order to secure uniformity in practice at ionospheric observatories. There was general agreement that the density of ionospheric recording stations over the world should be increased, particularly along the three lines of longitude, 150° E., 20° E. and 70° W.

The Brussels meeting of the Mixed Commission on the Ionosphere was presided over by Sir Edward Appleton, and in the course of its six sessions it surveyed in some detail our present knowledge of the ionosphere as obtained by direct radio exploration, and also by studies of auroras and geomagnetic phenomena. A number of resolutions were drawn up for consideration by the appropriate international scientific unions, with the view of enhancing the correlation of the characteristics of the ionosphere with geophysical and astrophysical phenomena.

At all the conferences there was universal agreement on the need for encouraging theoretical and experimental research on the mode of propagation of radio waves through the ionosphere, involving an increased and more precise knowledge of the absorption in the various regions, which is essential to the success of the forecasting of communication conditions. Particular attention was directed to the need for studying the technique of obtaining warning of disturbed conditions in the ionosphere, and communicating this to the practical user.

(*b*) *Propagation through the troposphere.* There was complete agreement at the Stockholm and London Conferences that it was necessary to proceed as rapidly as possible with the study of the propagation of waves at all frequencies above 30 Mc./s., in order to ensure the best and most efficient use of this end of the radio-frequency spectrum. At the lower end of this range, it is sometimes necessary to take ionospheric conditions into account; but in general at these frequencies, it is the propagation of such waves over the ground and the obstacles on it, and through the lower atmosphere, that is much more important in connexion with the practical applications of very short waves. It was recommended that simultaneous studies of radio-wave propagation and the associated meteorological conditions should be undertaken on as wide a basis as possible, and that the appropriate scientific radio and meteorological organisations should study the relevant characteristics of the troposphere in all parts of the world. In this connexion the need was expressed for improved techniques for measuring the vertical and horizontal gradients of temperature and humidity in the lower atmosphere, and the variations of these gradients with time and place. It was considered that the time is approaching when a suitable standard nomenclature might be drawn up for this subject, together with a uniform method of presenting both the radio and meteorological results.

These general recommendations were confirmed and elaborated by the Stockholm meeting of the Joint Commission on Radio-Meteorology, which held two technical sessions under the presidency of Dr. C. R. Burrows, of Cornell University. It was agreed that this Commission should direct its attention, as opportunity arose, to the theoretical and experimental determination of those properties of the lower atmosphere which affect radio propagation. These were deemed to include the study of storm detection by radar, and the location of sources of atmospherics by radio methods, as well as the actual transmission of radio-waves for communication or other purposes.

(*c*) *Long-wave propagation.* Following the lead given by the international bodies, the London Conference recommended that those Commonwealth countries in a position to do so should carry out a study of long waves propagated along the ground and through the ionosphere, and should seek the co-operation of other members of the Commonwealth when necessary. Partly in this connexion, it was considered important to increase our knowledge of the electrical constants of the ground, and all Commonwealth countries were urged to collect all appropriate information on this subject and arrange for its adequate distribution; and the United Kingdom was asked to prepare a survey of existing knowledge of the electrical constants of the ground at radio frequencies.

Radio Noise

In addition to the remarks already made above on this subject, the C.C.I.R. considered that atmospheric radio noise imposes one of the most important limitations on communications, and that therefore the study of such noise should be pursued on as wide a basis as possible. The conclusions agreed with those of the other bodies in recommending that meteorological studies should be undertaken to provide a knowledge of the distribution and nature of thunderstorms and the atmospherics originating from them. Investigations of the propagation of atmospheric disturbances and of the wave-forms and magnitude of the radio noise should be made in association with measurements of the direction of arrival at the receiver. Attention should also be given to the measurement of noise characteristics and their effects on receiving equipment in the frequency-range 10 kc./s. to 30 Mc./s., with particular reference to the range 10–300 kc./s.

The Commonwealth Conference endorsed the above recommendations and agreed to support the United Kingdom in the continuation and extension of a world survey of atmospheric noise-level by a subjective measuring method until the technique can be improved. It was further suggested that, in the interests of saving man-power and of ensuring that the quality of the data be as good as possible, particular consideration should be given by the United Kingdom to restricting the time schedule of such observations to the minimum necessary to obtain an adequate representative sample.

All meetings agreed that the work at present being conducted on solar and cosmic noise in various countries should continue on the existing lines.

Conclusion

The above notes are intended as only a general survey of the main conclusions of the conferences, and a more detailed consideration of the various recommendations must await the publication of the proceedings of the meetings in the usual manner. Apart from the actual committee work leading to these results, the various conferences provided the usual informal opportunities for meeting contemporary workers in other countries. The meetings in Sweden also enabled delegates to visit certain research and manufacturing organisations in Stockholm and Gothenburg.

R. L. SMITH-ROSE

LARGE-SCALE VERTICAL MOTION IN THE ATMOSPHERE

AT a meeting of the Royal Meteorological Society on February 16, the subject for discussion was large-scale vertical atmospheric motion. In opening, Mr. J. K. Bannon stressed the importance of the rising and sinking of large masses of air in atmospheric dynamics and explained the relatively small attention given to vertical motion by meteorologists by the fact that so far it has been impossible to measure directly the vertical velocities, which can only be inferred, and that with difficulty. He went on to describe a method of estimating up-currents from the rate of rainfall[1], depending on the approximate equality of the rate of release of precipitation from a mass of rising air and the rate at which the saturation vapour content of the same air decreases as the temperature falls due to adiabatic expansion (that is, neglecting the changing water content of the cloud particles, which is small except in convection clouds). This method can be applied in cases of steady rising currents over a wide area (thirty miles square or more), and examples of results obtained from rainfall records in the Hebrides show that up-currents in the lower and middle troposphere are of the order of 10–20 cm./sec. in typical disturbances of the North Atlantic.

Mr. J. S. Sawyer then gave a brief description of two other methods of deducing vertical atmospheric movement. The first, that of Graham[2], requires a network of upper air observations of temperature and wind at regular time intervals. The horizontal motion between consecutive times of upper air observations being known, temperature changes unexplained by horizontal movement are assumed to be due to changes in height, and to take place adiabatically; and hence the vertical motion in the period may be inferred. The method is quick and may be used by the weather forecaster; the results are consistent with other phenomena such as rain (up currents). The second method, which Mr. Sawyer has applied to several cases in the neighbourhood of the British Isles, depends on the relation between vertical motion and the divergence of the horizontal wind field (the equation of continuity), and between the divergence of the horizontal wind field and the rate of change of the vertical component of vorticity (the vorticity equation). Several approximations must be made, but even so the technique is rather laborious and the method is only suited to research. Notwithstanding the approximations, the results obtained agree qualitatively with expectations, up-currents being deduced over rain areas and down-currents over anticyclones; Graham's method gave comparable results. As emphasized later in the discussion by Dr. R. C. Sutcliffe, this vorticity method requires only knowledge of the pressure field—at more than one level, of course—and can be employed when wind observations are lacking.

Prof. P. A. Sheppard then gave a preliminary account of work being carried out under him in the Department of Meteorology of the Imperial College of Science and Technology by Mr. H. A. G. van Ufford and others. The eight radar wind-finding stations in the British Isles may be grouped to form seven triangles with sides of the order of 200–300 miles in length. The wind observations at the corners of these triangles (specially supplied by the Director, Meteorological Office, to the nearest degree in direction and the nearest knot in speed) were used to evaluate the horizontal divergence over each triangle, at 100 mb. intervals, between pressure-levels of 900 mb. and 200 mb., that is, approximately between 3,000 and 40,000 ft.; by the equation of continuity the vertical motion at each level was deduced from the horizontal divergence. The months December 1947–February 1948, inclusive, were investigated, and the large amount of data so obtained is still being analysed.

A few examples of results obtained were given. The weather of December 1947 was mainly anticyclonic over southern England, that of January 1948 very disturbed and cyclonic; frequency curves of the distribution of ρw (where ρ is air density, w is vertical velocity) for both the lower and upper troposphere reflect this, showing a preponderance of down-currents in the south of the British Isles in the first month; in the January, both in the north and the south of the country, almost equal numbers of up and down currents occurred, and larger vertical velocities were more frequent. Prof. Sheppard also demonstrated curves showing the distribution with height of the mean up and down velocities for January 1948 over central England. When there was general ascent below 500 mb. the maximum of just over 7 cm./sec. occurred between 600 and 500 mb., that is, about 16,000 ft.; with general subsidence in the troposphere, the maximum was between 6 and 7 cm./sec. and occurred between 500 and 400 mb. (about 20,000 ft.). It is noteworthy, he said, that in both cases the mean up and down currents, respectively, at tropopause-level are about 4 cm./sec. As well as the statistical results, which Prof. Sheppard stressed were the most important and significant outcome of the investigation, the distribution of vertical velocity was demonstrated for a few individual occasions, agreeing well with the general features of the weather (rainfall, development of ridges of high pressure, etc.). Velocities, both up and down, of up to 30–40 cm./sec. were deduced even in the lower stratosphere, though 10–20 cm./sec. were more usual maxima.

Mr. M. K. Miles said that, in using Graham's simple method, it is necessary to remember its limitations; as the author admits, it does not always lead to one definite value of vertical motion, and also the deduced velocity is an average over a considerable time, usually 6–12 hours. A comparison with Bannon's method, which tends to under-estimate the up current, and with a direct evaluation from horizontal wind observations, in one particular case, showed that Graham's method considerably under-estimates the vertical velocity.

Dr. R. C. Sutcliffe was enthusiastic of the results obtained so far by Prof. Sheppard. The network of upper air observing stations in the British Isles is the closest in the world, and this region should be used to determine the basic facts of the structure and working of typical weather situations. Atmospheric models, so determined, may then be applied to similar phenomena in other parts of the world where upper air information is scanty or lacking. Prof. Sheppard's investigation is an example of the use to which the British Isles observations may be put, to the great benefit of meteorology generally. Dr. Sutcliffe also pointed out that the horizontal scale of these vertical currents deduced by Prof. Sheppard is implicit in the dimensions of the triangles of observations used.

In reply to questions from Mr. C. S. Durst, Prof. Sheppard said that he had found no individual cases giving ridiculous values for the vertical velocities; since the radar wind observations are averages over depths of about 3,000 ft., such small variations in the wind as Richardson[3] feared would preclude any attempt at a numerical analysis of the wind field of a weather situation are probably eliminated. The time required to analyse each wind-finding ascent for all the various levels is about half an hour, using graphical methods. This indicates the large amount of work involved in producing the basic data for his investigation.

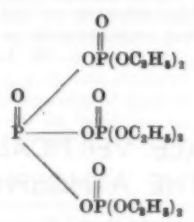
In concluding the discussion, the president, Sir Robert Watson-Watt, said that the results described showed exciting progress; as that most famous English meteorologist, Sir Napier Shaw, used to emphasize, measurements are as essential in meteorology as in every other branch of science.

[1] Bannon, J. K., *Quart. J. Roy. Met. Soc.*, **74**, 57 (1948).
[2] Graham, R. C., *Quart. J. Roy. Met. Soc.*, **73**, 407 (1947).
[3] Richardson, L. F., "Weather Prediction by Numerical Process" (Camb. Univ. Press, 1922).

INSECTICIDAL PROPERTIES OF CERTAIN ORGANO-PHOSPHORUS COMPOUNDS

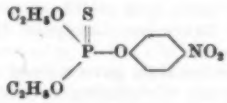
THE success of D.D.T. and benzene hexachloride insecticides has already shown the important part that synthetic chemicals can play in agriculture. Interest is therefore being shown in the organophosphorus group of insecticides, especially as certain of these compounds show high contact-activity and others are capable of rendering the plant systemically insecticidal. As these compounds have not yet been available in sufficient amounts for wide-scale investigations, and as little has been published on the subject, there is a considerable demand for accurate information. A meeting of the Association of Applied Biologists on November 5 sought to adjust this state of affairs by bringing together workers qualified to speak on various aspects of the subject.

Dr. H. Martin, of Long Ashton Research Station, introduced the proceedings. He referred to the classical work of Michaelis (1890–1915) on the chemistry of the organic compounds of phosphorus, and mentioned that Nylen[1] had described the tetraethyl ester of pyrophosphoric acid but had overlooked its toxicity towards insects. The discovery of, and information on, the insecticidal properties of these compounds was due almost entirely to Schrader[2]. He had shown that tetraethyl pyrophosphate is highly toxic to aphides, but had not carried forward his discovery to the manufacturing scale, as the substance rapidly lost its activity in contact with water. Instead, Schrader had investigated the reaction between phosphoryl chloride and triethyl phosphate and had obtained a product known as hexaethyl tetraphosphate (I), which he considered had the following structure:



(I)

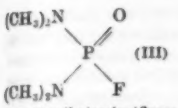
This substance was shown to be as toxic to aphides as nicotine and to have sufficient water-stability to be of practical value; consequently, its manufacture was commenced in Germany in 1944. Dr. Martin mentioned that chemical evidence had recently been produced that hexaethyl tetraphosphate is probably a mixture of alkyl polyphosphates; but investigations at Long Ashton on the toxicity of samples prepared by different processes had revealed no differences. However, it is not sufficiently stable for use with alkaline spray material such as lime sulphur or for incorporation in dusts, consequently its usefulness to agriculture is limited. Schrader found that the thiopyrophosphoric esters were more stable to hydrolysis than the pyrophosphoric esters, yet retained their pronounced insecticidal action. In 1945 a series of thiophosphoric acid derivatives was investigated, with the result that the highly potent insecticide, diethyl-*p*-nitrophenyl thiophosphate *E*.605 (II), was discovered.



(II)

E.605 was a marked improvement on hexaethyl tetraphosphate. It is more toxic to many species of aphides than nicotine, giving a complete kill at 0·005 per cent (Schrader), and is sufficiently resistant to hydrolysis to be used with lime sulphur or as a dust. It is also ovicidal, being about as toxic to *Aphis pomi* eggs as 3 : 5-dinitro-*o*-cresol. Claims had been made that *E*.605 was toxic to a wide range of insects. Schrader found that diethyl-*p*-nitrophenyl phosphate (*E*.600) was also highly insecticidal, but had not gone further with this compound on account of its toxicity to mammals.

Dr. Martin then referred to the discovery of the systemic insecticides by Schrader and Kükenthal[3]. Apparently these workers had included a soil-watering test in their routine examination for insecticidal properties, and had found that certain organic compounds could be absorbed by plants, which thereby became toxic to insects placed on them. Few of the systemic insecticides described by Schrader are available in Great Britain, but three have been examined at Long Ashton:

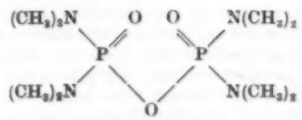


(III)

Bis-(dimethylamino)fluorophosphine oxide

$CH_2(OCH_2CH_2F)_2$ (IV)

Bis-(2-fluoroethoxy)methane



(V)

Pyrophosphoryl tetrakis dimethylamide

Dr. Martin considered that the systemic insecticides would prove of value in the investigation of translocation in plants, but he deprecated their practical use for insect control before it is known whether or not they are toxic to mammals or give rise to toxic products in the plant.

Dr. H. E. Coates discussed points of chemical interest concerning the phosphorus insecticides, particularly methods of synthesis and questions of chemical constitution. He said that hexaethyl tetraphosphate is a mixture of linear polyphosphoric esters, hexaethyl tetraphosphate, pentaethyl triphosphate, tetraethyl pyrophosphate and unreacted triethyl phosphate, together with a small amount of acidic by-product. The branched structure (I) suggested by Schrader is incorrect because only a small amount of *ortho*-phosphoric acid is obtained on hydrolysis, whereas the branched formula should give one molecule of *ortho*-phosphoric acid per molecule of the substance. The explanation of linear ester formation is that phosphoryl chloride and triethyl phosphate disproportionate on heating to give a mixture of diethyl chlorophosphonate and ethyl dichlorophosphonite, which then reacts with more triethyl phosphate to give the linear esters. Two methods for the preparation of tetraethyl pyrophosphate were given; the first, of academic interest only, uses silver pyrophosphate and ethyl iodide, but the second, from diethyl chlorophosphonate and triethyl phosphate, is applicable to large-scale production. *E*.605 can be prepared by allowing thiophosphonyl chloride to react with alcoholic sodium ethoxide, the resulting diethyl chlorothiophosphonate being heated with sodium *p*-nitrophenate in chlorobenzene. In the synthesis of bis-(dimethylamino)fluorophosphine oxide, it was shown to be advantageous to cause one molecule of phosphoryl chloride to react with four molecules of dimethylamine to give bis-(dimethylamino)phosphoryl chloride $[(CH_3)_2N]_2POCl$; this gave the desired end-product on reaction with sodium fluoride. Reference was made to a recent colorimetric method[3] for the estimation of *E*.605.

Mr. S. H. Bennett described preliminary experiments with systemic insecticides, referring to certain organo-phosphorus compounds, and to bis-(2-fluoroethoxy)methane, which had been investigated by Schrader, and also to sodium selenate, the systemic properties of which are more generally known. Schrader's findings had first been confirmed at Long Ashton when groundsel plants watered with a 1 per cent solution of bis-(2-fluoroethoxy)methane were shown to be highly poisonous to fully grown larvæ of the cinnabar moth (*Callimorpha jacobææ*). Similar results were obtained using tick bean plants inoculated with bean aphis (*Aphis fabæ*); infestations occurred only on untreated plants. It was found that bis-(dimethylamino)fluorophosphine oxide and bis-(2-fluoroethoxy)methane had powerful systemic properties, but pyrophosphoryl tetrakis dimethylamide was only weakly systemic. These compounds act as fumigants as well as contact poisons; but tests of the former activity failed at first because of the difficulty of separating the fumigant effect of the material in the leaf from that in the soil. This difficulty was overcome by rooting willow plants in water culture, transferring to the insecticide solution and returning to the water culture again when sufficient material had been absorbed, after which it was possible, by assuming uniform distribution of insecticide throughout the plant tissue, to calculate the amount present in a leaf. The fumigant effect was then tested by placing brassy willow beetles (*Phyllodecta vitellinæ*) on muslin with the plant material below and enclosing the whole in a glass vessel. In these circumstances it was found that the fumigant activity of the insecticide in the plant tissue was a hundred times as great as might have been expected from comparable experiments with aqueous solutions. Further experimental work is desirable to explain this effect, which may be the result of differences in the partial pressure of the fumigant in the two systems.

In further experiments, *Calandra granaria* were fed on grain from plants which had been watered with solutions of bis-(2-fluoroethoxy)methane or sodium selenate. While neither compounds caused the grain to become directly toxic to the weevil, infestation did not build up in the selenate-treated wheat, and it appeared that the reproductive powers of the insect had been affected. Referring to the phytotoxicity of these compounds, Mr. Bennett mentioned that bis-(dimethylamino)fluorophosphine oxide is the most toxic to plants growing in soil, but in water culture pyrophosphoryl tetrakis dimethylamide has caused serious plant damage.

In the general discussion that followed, Dr. J. K. Eaton referred to the ovicidal properties of *E*.605 and related compounds. He said that, of the twenty-seven substances examined at East Malling, only *E*.605 and *E*.600 (diethyl-*p*-nitrophenyl phosphate) showed appreciable toxicity to winter moth eggs (*Operophtera brumata*). The eggs of the green apple aphis (*Aphis pomi*) were more susceptible to the action of these organo-phosphorus esters, *E*.600 and di*iso*propyl-*p*-nitrophenyl phosphate giving complete kill at 0·005 per cent. The results indicated that toxicity to *Aphis pomi* eggs is associated with the incorporation into the phosphoric or thiophosphoric acid molecule of two alkyl groups and an aryl group. Toxicity is increased by the introduction of electron-attracting groups in the *para* position of the aryl substitutent. Preliminary field trials for the control of certain species of aphides using *E*.605 and hexaethyl tetraphosphate had been carried out. The results showed that both give control equal to or better than nicotine at the same concentration; *E*.605 is generally the superior. No phytotoxic effects had been noted.

Mr. R. S. Pitcher said that a high kill of the raspberry cane midge (*Thomasiniana theobaldi*) had been obtained under conditions in which *E*.605 appeared to exert an ovicidal effect at a distance. Dr. Martin replied that there was little evidence that *E*.605 had systemic properties, and he considered that the action could be explained as a fumigant effect. Answering a question concerning the use of systemic insecticides marked with radiophosphorus for following the movement of these compounds in plants, Dr. B. A. Kilby said that work had just started at

the University of Leeds on the synthesis of such compounds. The most convenient synthesis used phosphoryl chloride as the starting material; but radiophosphorus is most readily available as inorganic phosphate, and the conversion of this to phosphoryl chloride is not easy. The difficulty might be overcome by the discovery of a suitable exchange reaction or by a supply of radiophosphorus in a more convenient form.

Dr. R. A. E. Galley urged that the nomenclature of the organo-phosphorus compounds should be standardized and favoured the introduction of trivial names for the better known phosphorus insecticides.

J. K. EATON

[1] *Z. anorg. Chem.*, **212**, 182 (1933).
[2] *Brit. Intell. Obj. Sub-comm.*, Final Report 714 (1947).
[3] *Anal. Chem.*, **20**, 753 (1948).

'MECHANISM' OF *PHYTOPHTHORA*-RESISTANCE OF POTATOES

By K. O. MÜLLER and LOTHAR BEHR*

USING as a basis the American 'native forms' of the tuber-bearing species of Solanaceæ, German breeders during the last two decades have developed potato varieties with both leaves and tubers resistant to most of the known races of *Phytophthora infestans*. It is true that the origin and initial constitution of the material which was used for the breeding of these varieties is only imperfectly known; but we know that its refractory behaviour towards the *Phytophthora* fungus is associated with a gene *R* which is not found in any European variety of the old-fashioned type. Furthermore, according to K. O. Müller, this resistance gene has several associated alleles and is inherited independently of other economically important characters, such as yield capacity, time of maturity, and the like. Therefore it did not take very long to combine the *Phytophthora* resistance of these '*W* varieties' with the high yielding-capacity and other inherent qualities of the European cultivated potato. The first German commercial varieties resistant to *P. infestans* which appeared on the market were Erika (1941), Robusta (1941), Fruehnudel (1941), and Aquila (1942). There are at present in Germany ten new registered potato varieties, all of which possess this resistance gene.

Investigation into the mode of action of this gene, particularly as regards the tubers, led to the conclusion that the alleles present in the *W* varieties are not responsible for the resistant condition itself, but induce only a genetic predisposition of the tissues to 'acquire' a local immunity from infection when they come into contact with the hyphæ of parabiontic races of *P. infestans* (that is, those strains which kill the cells quickly, thereby arresting the further growth of the hyphæ). From the physiological point of view, whether or not a variety is resistant is not decided until the parasite has penetrated into the host tissues. Comparative investigations into the reactions of susceptible and resistant genotypes revealed that in both the host cell is destroyed after coming into contact with the protoplasm of the parasite. Judging by the morphological and physiological changes the final effect is the same—the cell collapses and loses its ability to serve the parasite as a host. But the rapidity with which this final effect is achieved differs in susceptible and resistant genotypes. While the cells of the former live relatively long—six to fourteen days at 19–21° C.—those of the latter die after one or two days, the process being too rapid for fructification of the fungus to occur; moreover, further penetration by the hyphæ is made impossible by the rapid reaction of the host tissue, which in the course of this reaction also loses its ability to serve as a host to eusymbiontic fungus strains (that is, strains which can invade the host tissue without killing it quickly). Other pathogenic micro-organisms, too, are unable to use such 'immunized' tissues as nutritive substrates. The reaction is therefore unspecific (K. O. Müller and H. Boerger).

Cytological-physiological investigations by K. O. Müller, G. Meyer and M. Klinkowski in 1938 showed that it is possible to distinguish in this 'defence-necrosis' at least five successive stages, the last two being characterized by cell collapse and by a heavy infiltration of the cell-walls and cytoplasm with phlobaphene-like compounds, which appear to arise, according to Meyer (1939), through polymerization of tannic substances. These can be demonstrated by the usual tannin reagents after infection in host cells which are still alive.

This close relation between the degree of resistance and the rapidity with which necrosis is brought about was demonstrated in extensive breeding material, consisting partly of previously unselected *F*2 families of crosses between 'resistants' and 'susceptibles'. It was also shown that the two extremes, 'highly susceptible' (the parasite penetrating uniformly through the entire tuber and fructifying luxuriantly) and 'highly resistant' (the parasite penetrating only a few cell-layers of the parenchyma of the tuber and then ceasing to grow without fructifying), are connected by at least two genotypically conditioned intermediate types. These are characterized by an intermediate reaction-rate and—in agreement with what has just been said—their tubers are penetrated to a considerable depth by the parasite (K. O. Müller).

Other investigations led to the conclusion that the 'defence necrosis' is induced by substances secreted by the parasite into the host tissue. Accordingly, the specific behaviour of the resistant genotypes would appear to depend on a specific sensitivity of the protoplasm, controlled by gene *R*, so that the highest reaction-rate would be associated with the greatest degree of resistance. Because the susceptible genotypes also react to these substances, there appears to be no fundamental, but only a graduated, difference between 'resistants' and 'susceptibles', and we conclude (paradoxical though it may appear at first) that the greater the sensitivity of the cells to the metabolic products of the parasite, the greater the resistance of the tuber. Further, the resistance gene *R* is not a factor *sui generis*; it only accelerates a reaction which the susceptible genotypes are also capable of producing. There is, however, a further conclusion. In the course of the reaction the host tissue loses the ability to serve as a nutrient substrate for the fungus. As not only *P. infestans*, but also other micro-organisms which can thrive on a wide range of organic matter (*Rhizopus nigricans*, *Aspergillus niger*, and others), are not able to exist in the necrotic, transformed tissue, the necrosis of the affected tissues must be accompanied by the formation or activation of a principle ('phytoalexin') which

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exercises a retarding influence on the penetrating parasite. In these circumstances necrosis would depend less on the absolute reaction-rate and more on the relation between the hyphal growth-rate (*Cp*) and the rapidity with which the principle forms (*Cw*). Hence with increasing $Cp : Cw$ values the resistance would decrease, while with decreasing values it would increase.

From experiments in which the influence of temperature on the reaction in various genotypes was examined, valuable insight was obtained into the dynamics of the defence mechanism described above (K. O. Müller and R. Griesinger). At low temperatures (5–10° C.) the immunological behaviour of the susceptible genotypes strongly resembled that of the resistant ones. But on the other hand, no decrease in the capacity for resistance in the resistant genotypes was induced. This, however, was achieved in another way, and for this K. O. Müller and L. Behr started from the following hypothesis. If it were possible in the resistant genotypes to retard the necrosis of the tissues affected by the fungus by some kind of chemical or physical treatment of the tubers, the development of the fungus would be promoted simultaneously. The parasite would be able to penetrate farther into the tissues than in the untreated tubers, and at the same time would also fructify.

The experience of other workers (Salmon, Stakman, Bolle, Gassner and Hassebrauck), who have studied the effect of narcotics on the immunological behaviour of plants against fungal parasites, suggested the materials to use for such experiments. The tubers of resistant and susceptible genotypes were treated with methyl, ethyl, propyl, butyl, *iso*propyl, and *iso*butyl alcohol (water–alcohol mixtures), and were inoculated *after* treatment. Germination tests with sporangia of *P. infestans* in alcohol–water mixtures showed that the concentrations used did not check the development of the parasite. The results were as anticipated. The treatment of the tubers with the alcohols above mentioned prolonged considerably the life of the cells which had come into contact with the parabiontic strain of *P. infestans* (retardation of cell collapse, inhibition of phlobaphene formation). At the same time—and this is most important—a material increase in the development of the fungus followed, which in many cases went so far that the parasite developed thick aerial mycelium (with sporangia), even in the highly resistant types.

The accompanying table shows the effect of ethyl alcohol on the immunological behaviour of a highly resistant *W* variety.

That the tubers were *in toto* still alive after the alcohol treatment was shown by the ability of parenchyma cells to become plasmolysed and by the fact that non-inoculated tubers, treated with a 3–5 per cent alcohol–water mixture, could be stored for weeks at room temperature and high air humidity without showing any rotting symptoms caused by facultative parasites.

A comparison of the effects of the four normal alcohols showed that a close correlation exists between the length of the carbon chains and their effect in reducing resistance. Richardson's 'law of homologous series' has thus been confirmed. Furthermore, *iso*propyl and *iso*butyl alcohol were considerably less effective than the normal alcohols. This result, too, agrees with the findings of previous workers, who maintained that the greater the branching of the carbon chains, the less the narcotic effect.

Effect of ethyl alcohol on the immunological behaviour of the *W* variety *BRA* 23/31

Concentration of alcohol (% volume)	Reaction of the host			Development of the parasite	
	Necrotic changes immediately beneath the site of inoculation		Phlobaphene-formation within the tuber	Aerial mycelium (sporangia)	Within the tuber
	after 48 hours	after 120 hours	after 120 hours	after 120 hours	after 120 hours
0 (Control)	very strong	very strong	very strong, distinctly limited (2–3 cell-layers)	none	no mycelium outside the necrotic tissues
3	weak	strong	weak, diffuse, up to a depth of about 10 mm.	thin	parasite penetrated up to about 35 cell-layers
5	weak	strong	,,	thin	,,
10	very weak	very strong	very weak (greatly variable in extent)	thick	penetration up to about 15 cell-layers
12	very weak	very strong	extremely weak, diffuse	very thin	penetration up to about 7 cell-layers

The results of these experiments with narcotics have thus confirmed the original theory developed on a genetic basis: the greater the rapidity with which the host cells in contact with the fungus react to the metabolic products excreted by the fungus, the greater the resistance of the plant. The results also suggested a satisfying physiological explanation of the effects of narcotics in decreasing resistance, noted already by previous workers on other organisms, though differently interpreted. Details cannot be given without exceeding the scope of this short article, but our interpretation appears to have the advantage of explaining satisfactorily many effects, with only one premise to be recognized, namely, the greater the reaction-rate, the greater the resistance.

The effect of chloroform (applied as a vapour) has also been tested, and the result agreed with the above findings. This leads to the conclusion that the action of narcotics on the 'resistance mechanism' is an effect connected with the primarily unspecific changes in the physico-chemical structure of the host cell. As other observations point to the fact that the necrobiosis is connected with the respiratory metabolism of the host cell, it can be assumed that it is this metabolism which the narcotics affect first. This would also hinder the course of the defence necrosis and simultaneously postpone the material changes in the host cell, which we must consider to be the direct physiological cause of the 'defence' against the parasite.

Whether or not this attempted explanation conforms with the facts, we can deduce from the results that the necrobiosis of host tissue, induced by a parabiontic strain of *P. infestans*, is essentially an active response of the affected cells, very probably connected with an increased release of energy. If the defence necrosis of the resistant genotypes induced by fungal contact were the same as a passive dying, such as we can observe, for example, after the effects of supramaximal or inframinimal temperatures, it would appear incomprehensible why just those substances, which in our experience had only a paralysing effect on cell activity, should increase the longevity of infected cells.

SEISMOLOGY IN BRITAIN

A VERY wide range of activity in the fields of pure and applied seismology by British seismologists is referred to in the recently published fifty-third report of the Committee on Seismological Investigations of the British Association for the Advancement of Science.

The work of the International Seismological Summary is carried out by a staff of three, headed by Mr. J. S. Hughes. Through the courtesy of the director of the Meteorological Office it is housed in two huts at Kew Observatory. The bound volumes for 1936 have been issued, as also have more recent quarterly parts. Manuscript for 1937 is compiled. The past year has seen the change-over from the use of normal geographic co-ordinates for the positions of observing stations as a basis for the estimate of travel times to that of geocentric direction-cosines. Such a change means that no distances, calculated for epicentres used before 1937, can be used for preliminary epicentres. The slowing up of the work, now that the system is well in hand, is thought, however, to be inappreciable. Prof. H. Jeffreys (director) and Mr. J. S. Hughes now wish to know what readings they may expect to receive from observatories for the period after the outbreak of hostilities in 1939.

There have been few British earthquakes recently. The earthquake of May 28, 1948, at 17h. 02½m., G.M.T., was felt over a considerable region of Norfolk, Suffolk and Cambridgeshire, but was accompanied by no appreciable damage. It was recorded by the Kew seismographs, both short-period and Galitzin, *Pg* occurring at 17h. 02m. 53s. G.M.T. and *Sg* 14 sec. later; the distance from Kew was therefore about 120 km. Dr. A. T. Dollar, of the University of Glasgow, has resumed the collection of macroseismic data concerning British earthquakes, and it is hoped to publish his collected observations on the small earthquakes of April 2, 1948, at Bethesda, Carnarvonshire, and May 31, 1948, at Ullapool, Ross-shire, together with later observations in 1949.

Two of the Committee's seismographs were removed from the University Observatory, Oxford, to Down House, Downe, Kent, in 1937, and were put in the care of Dr. O. J. R. Howarth. They were assembled by Miss E. F. Bellamy and later calibrated by Mr. J. S. Hughes and Mr. E. N. Lawrence. Dr. Howarth has since been comparing the seismograms which he has obtained with the readings from the seismograms obtained at the observatories at Kew and Durham, and also with the preliminary epicentres on the cards issued by the United States Coast and Geodetic Survey; he has also sent observations on microseisms to Dr. G. E. R. Deacon at the Admiralty Research Laboratory. In addition, the Committee has Milne–Shaw seismographs at Edinburgh (recording suspended), Cape Town, Perth (Western Australia) and Suva (Fiji), and a Jagger shock recorder at Comrie, Perthshire.

The seismological work of the Department of Geodesy and Geophysics at the University of Cambridge has included Prof. E. R. Lapwood's theoretical investigation of the diffraction effects at the surface of a semi-infinite homogeneous elastic medium after a pulse has been emitted by a buried line source. Prof. Lapwood has shown that at distances large compared with the depth of the source, the disturbance at the time of arrival of the direct *S*-pulse differs from that at the time of arrival of the *P*-pulse in being smudged or blunted. Some seismic work at sea has been done; microseisms with frequencies greater than 8 cycles per sec. have been investigated and are thought to be man-made; and short-range explosion seismology has been done in the Lake District and in Wales. Mr. P. L. Willmore has designed a moving-coil seismograph with a nearly constant response to ground velocities of frequency 2–25 cycles per sec., and a maximum sensitivity of 5,000 cm. per cm. per sec. Mr. M. N. Hill has designed a long-period inductance-bridge seismograph. Mr. Willmore spent several months in Germany, arranging for seismological observations to be made on the tremors from the explosion on Heligoland of nearly 4,000 tons of ammunition on April 18, 1947. Observations were made by portable seismographs in Germany, chiefly from the Geophysical Institutes at Göttingen and Celle, in Holland and in Denmark, and by two ships in the North Sea. The tremors were also recorded by observatory seismographs in Belgium, France, England, Czechoslovakia and Switzerland. Travel times were observed at distances of 50–1,000 km. from Heligoland; these were supplemented by the observations up to 50 km. of the explosion of about 400 tons of explosive near Soltau in the autumn of 1946. The characteristics of the artificial earthquake wave phases are given in the table, which also includes figures for the thicknesses of the assumed layers.

Phase	Velocity	Starting time	Thickness	Standard deviation of one observation
Sedimentary *P* wave	1·6 – 5·4 km./sec.	0	9·01 ± 1 km.	—
Pg (Near stations)	6·06 ± 0·09	2·8 ± 0·17	17·4 ± 2 km.	0·16 sec. on regional means
Pg (Distant stations)	4·9 – 5·5	—	—	3 sec. for 1 layer. 0·50 and 0·86 for 2 layers
Pn	8·18 ± 0·014	7·37 ± 0·1	—	0·19 sec.
Sn	4·36 ± 0·06	2·8 ± 1·3	—	0·43 sec.
R	3·05 ± 0·1	4·6 ± 6	—	3·6 sec.

R appears to be a wave, according to Willmore, which was propagated through the ultrabasic layer, after suffering reflexion from the surface at one point in its path. Prof. C. Charlier is of the opinion that this observed phase was propagated through a separate layer in the earth. Calculations from the measurement of seismograms give a value of 10^{17} ergs for the energy transformed into earthquake waves by the whole explosion. Measurements of the crater show that $1{\cdot}5 \times 10^{18}$ ergs were expended in moving the rock above the charge, while the total thermal energy of the explosive was $1{\cdot}3 \times 10^{19}$ ergs.

Dr. G. E. R. Deacon reports that work at the Admiralty Research Laboratory seems to throw some light on the origin of microseisms. It has been shown that pressure fluctuations due to sea-waves likely to be responsible for microseisms occur when there is interference between sea-wave groups of the same frequency travelling in opposite directions. This interference may arise in the neighbourhood of a fast-moving depression over the sea, or in a coastal region where energy is being reflected from the

shore. The theory suggests a definite two to one relationship between the periods of the sea-waves and microseisms, which has been confirmed by observations. Further, by submitting simultaneous records of waves and microseisms to frequency analysis, it has been thought safe to conclude that a depression moving rapidly over deep water north of the Azores caused microseisms at Kew. Microseisms on Kew seismograms can be detected some thirty hours before the swell from a distant storm reaches the coast.

ERNEST TILLOTSON

MAGNETIC AMPLIFIERS

THE thermionic valve amplifier is so universal in its application that even the existence of other means of amplifying tends to be overlooked. Two papers read recently before the Institution of Electrical Engineers record developments in magnetic amplifiers, and indicate the field of application within which such amplifiers possess advantages. These papers, "Magnetic Amplifiers", by A. G. Milnes, and "A Theoretical and Experimental Study of the Series-Connected Magnetic Amplifier", by H. M. Gale and P. D. Atkinson, were presented on December 2, 1948.

Essentially the principle of the magnetic amplifier is that of controlling the current in an A.C. circuit by varying, by means of an auxiliary D.C. circuit, the impedance of an iron-cored reactor in series with the load. The D.C. circuit thus effects its control by producing magnetic saturation of the reactor core. This principle has been known and has been applied for many years, indeed since the period of the First World War; but it was not until high-permeability nickel–iron alloys and metal rectifiers became available that rapid development of the magnetic amplifier for a wide range of applications took place.

The basic circuit arrangements of magnetic amplifiers have now assumed fairly well established forms, and the present papers give a systematic theoretical treatment and design procedure for the standard circuits. As a rule the magnetic amplifier operates as a D.C. amplifier in the sense that the input or controlling current is a small direct current, and the output is again a direct current produced by the rectification of the alternating current passed by two reactors, the reactance of which is controlled by the input. A simple, single-stage magnetic amplifier employing high-permeability cores might give a power-gain of the order of 10 to 20. This gain may be very greatly increased, however, by the use of positive feed-back. Feed-back is applied by circulating the direct output current through an additional winding on the cores. If the magnetic effect of this feed-back winding is in such a direction as to reinforce that of the input current, there is partial self-excitation which increases the ratio of output current to input current. The effects of feed-back are closely analogous to those obtained with thermionic amplifiers, and excessive positive feed-back will give rise to instability. Positive feed-back is commonly utilized to obtain power gains per stage of the order of 2,000. Without feed-back a magnetic amplifier does not discriminate between positive and negative input signals; but with the application of feed-back, reversal of the polarizing flux changes the feed-back from positive to negative, and discrimination results. Magnetic amplifiers commonly operate with input powers of the order of a microwatt, and it is stated in one of the papers that 10^{-9} watt may be regarded as the lower usable limit of input power.

Perhaps the most significant difference between the behaviour of the magnetic amplifier and that of the thermionic amplifier lies in the time delay of the response of the magnetic amplifier to a sudden change of input. The build-up of the steady state following a sudden alteration of input is approximately exponential, and the response-time of magnetic amplifiers is usually expressed as the time-constant of an approximately equivalent exponential rise. This time delay, which is practically inversely proportional to the frequency of the A.C. supply and increases in proportion to the stage amplification, is one of the important limiting factors in the application of magnetic amplifiers. In order to obtain a high ratio of amplification to time-constant it is desirable to connect a number of stages in cascade, since the overall amplification is the product of the amplifications of the individual stages, whereas the total time-constant is, very roughly, the sum of the time-constants of the stages.

It is interesting to note that in the two papers the theoretical analysis proceeds along quite different lines, and different approximate-design techniques are developed. It is pointed out that a magnetic amplifier to control a given power output is ordinarily considerably larger than the corresponding power transformer, and supply frequencies in the range 400–1,600 c. s. are commonly employed in order to reduce the size of the equipment. The equivalent exponential delay of an amplifier is stated to correspond to a time-constant of the order of 2–100 cycles of the supply frequency.

JAMES GREIG

RECRUITMENT AND TRAINING FOR THE IRON AND STEEL INDUSTRY

IN order that the continuous and rapid technical developments in the iron and steel industry shall not outrun the capabilities of the men who will be required to operate the processes involved, the British Iron and Steel Federation has recently prepared recruitment and training schemes to benefit the industry as a whole. Based on the experience gained by various firms who have already developed training programmes of a far-reaching character, the Recruitment and Training Committee of the Federation has introduced a sample training scheme which has been circulated to all member firms. In order that the scheme should be fully discussed and improved, a Conference was held at Ashorne Hill, Leamington, on January 14–16, 1949, under the chairmanship of Mr. Gerald Steel, joint managing director of the United Steel Companies. The Conference was attended by representatives of member firms from all parts of Britain, and included production managers as well as personnel officers of various grades.

Pointing out that the number of youths in industry between the ages of 14–18 years had fallen from 3¼ millions in 1938 to 2¼ millions in 1947, Mr. A. Goodram, of Samuel Fox and Co., Ltd., discussed the training of the junior operative both from the economic and social points of view. In his own Company the

scheme began with a period of three weeks pre-entry training in which the change-over from school to work was cushioned and gave the boy and girl some idea of the shape and importance of the firm and of its general organisation. The boy's first job as a messenger lasted eight months, and during this time he obtained more information about individuals, departments and processes. The next phase of training was given in the workshops, when suitable boys were selected as craft apprentices. Junior operatives were then placed in production departments until they were called up for National Service; but during this time they would be given experience in at least three departments as well as opportunities for attending educational institutions on one day a week.

The director of training at Stewarts and Lloyds, Ltd., Mr. Graham Satow, then outlined a scheme for training craft apprentices and suggested re-introduction of the formal method of 'agreements'. Training should include both technical and general aspects, and should be the joint responsibility of the firm and the local education authority. For the more able apprentice, education up to the ordinary and higher national certificate standards should be provided, while for the craftsman who was good with his hands a less academic examination should be instituted. Practical training should be done by the firm, and should include experience in the use of hand and machine tools as well as the actual jobs associated with the boy's future work. Selected craft apprentices should be given both the opportunity of moving up to the technical apprentice-level and of sitting for State technological scholarships.

In opening a discussion on the training of technical apprentices, Mr. Cleghorn Thomson, chief education officer of Richard Thomas and Baldwins, Ltd., indicated that these would generally be recruited from grammar school boys of matriculation standard. His suggestions for training this type of apprentice presupposed that ultimately the heads and chief assistants in the chemical, metallurgical and fuel departments of the larger works would all be honours degree men, or associates of the appropriate professional bodies, that ordinary degree men would be in charge of the main sections under them, and that foremen testers and senior chemists and testers should have at least higher national and national certificates, respectively. Training of technical apprentices in the works should provide progressive movement linked up with their theoretical studies and success in examinations. The period of training would last about five years and would include time spent in other firms. During the ensuing discussion the doubt was expressed whether it would be practicable to insist on matriculation as the prerequisite for this type of entrant to industry, while the need for universities to provide more facilities for part-time studies was strongly advocated.

The training of clerical workers was introduced by Mr. D. R. O. Thomas, chief education officer to the United Steel Companies, who emphasized that this was an aspect of industrial training which had not been given the attention that its importance required and merited. The national certificate in commerce had not yet gained wide acceptance mainly because it had not been sponsored by any single authoritative body. This situation may be altered after the Carr–Saunders Committee, which is deliberating at present, has reported. The training should include preliminary instruction in the history and organisation of the firm, practical training in various departments and, concurrently with the practical training, theoretical training at a commercial college which should not be over-weighted on the vocational side. In summing up this particular session, the chairman insisted that the training provided "must wipe out that unfortunate figure, the routine clerk keeping up appearances on a miserable pittance".

Probably the most difficult subject at the Conference, training in the small firm, was tackled by Mr. A. Roebuck, technical director of Hadfield's, Ltd. Training in the small firm is as necessary as in the big firm, and Mr. Roebuck believed that this would be achieved if small firms would co-operate in groups on a trade or geographical basis. This is already happening in some parts of Great Britain, and in order to extend training facilities throughout the country it is proposed to set up local committees in various steel-making areas to help in the organisation of suitable training schemes. In this way large and small firms would be able to help each other, the small firm often making a contribution to training which was impossible in the bigger firm.

In surveying the work of the Conference, Mr. Geoffrey Summers, director of John Summers and Sons, Ltd., emphasized that all technical training needed to be reinforced with social and humanistic education in which young industrial workers should be taught how to make their leisure a period of profitable active enjoyment.

The Conference closed on an evangelical note with the following remarks by Mr. G. Steel. "We must proselytize. We must make everyone training-conscious. For the welfare of our own industry and the country as a whole, it is essential that we succeed. Only thus can we ensure that the best possible use is made of our strictly limited resources."

These words, and the calling of the Conference, indicate the way in which the iron and steel industry in Britain is adjusting itself to become more and more efficient in a world that daily grows more competitive.

T. H. HAWKINS

POTATO VIRUS *X*

THE drastic roguing which is performed on crops of potatoes for seed has resulted in a reduction of the amount of the more obvious viruses leaf-roll and rugose-mosaic. Potato virus *X*, however, causes a slight mottle of the foliage which is noticeable only under certain conditions of weather, and may often be missed by the roguers. F. C. Bawden, B. Kassanis and F. M. Roberts conclude, in a recent paper (*Ann. App. Biol.*, **25**, No. 2, 250–265; June 1948), that the control of virus *X* must involve methods additional to those of field inspection. Presence of the virus in a stock of potatoes can be tested by inoculation to indicator plants and by serological methods. Spread of the virus is slow under natural conditions, and the authors conclude that the maintenance of stocks from which virus *X* has been eliminated by testing is feasible under commercial conditions. The virus reduces yield by 5–24 per cent; but it is refreshing to find the idea of clonal selection also considered along with questions of yield and loss due to virus.

Potato virus *X* is shown by F. M. Roberts (*Ann. App. Biol.*, **35**, No. 2, 266–278; June 1948) to be transmitted by contact of leaves or roots. About ten per cent of healthy plants in contact with diseased

ones become infected, and the more virulent strains of the virus spread more rapidly than the less virulent ones. The rate of spread is much greater in tomato than potato plants. *Datura stramonium* and tomato, indeed, become infected when grown in soil containing only sap or residues from virus-infected plants. The fungus *Rhizoctonia solani* cannot effect transfer of virus *X*.

Variations in the properties of virus *X* have been studied by F. C. Bawden and A. Kleczkowski (*J. Gen. Microbiol.*, 2, No. 2, 173; May 1948). Concentration of the virus extract by high-speed centrifugation or precipitation with acids and salts results in an insoluble form of the virus which is, nevertheless, infective and serologically active. Ribonuclease readily hydrolyses the nucleic acid derived from virus *X*, but has no action on the active virus.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, March 28—Wednesday, March 30

CHEMICAL SOCIETY (joint meeting with the CHEMISTRY DIVISION of the ATOMIC ENERGY RESEARCH ESTABLISHMENT, at Rhodes House, South Parks Road, Oxford).—Symposium on "The Chemistry of the Heavy Elements".

Tuesday, March 29

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Wm. A. Singleton: "Impressions of Sweden".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON AND DISTRICT SECTION (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Prof. H. W. Melville, F.R.S.: "Redox Polymerization". (Members of the Plastics Group of the Society of Chemical Industry are invited.)

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Dr. C. Melville, Mr. H. Steinman Mr. J. B. Lloyd and Mr. H. Burlinson: Papers on "Different Aspects of Pharmacy".

Wednesday, March 30

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, 16 Princes Gate, London, S.W.7), at 3 p.m.—Ninth Annual General Meeting; at 3.15 p.m.—Discussion on "Photoelectric Spectrophotometers and Tricolorimeters" (to be opened by Dr. T. Vickerstaff)

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Dr. Hill: "Chemistry at the Shirley Institute".*

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (joint meeting with the BRITISH ASSOCIATION OF CHEMISTS and the ASSOCIATION OF SCIENTIFIC WORKERS, at Gas Industries House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Discussion on "Part-time Education in Chemistry".

Wednesday, March 30—Friday, April 1

INSTITUTE OF METALS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, on March 30 and 31, and at 4 Grosvenor Gardens, London, S.W.1, on April 1), at 10 a.m. each day—Annual General Meeting.

Thursday, March 31

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—108th Annual General Meeting; at 3.30 p.m.—Sir Ian Heilbron, F.R.S.: "Concerning Amino-acids, Peptides and Purines" (Presidential Address).

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. H. Marsden: "Nylon Yarn Processing in U.S.A.".

Thursday, March 31—Monday, April 4

BRITISH PSYCHOLOGICAL SOCIETY (at Bristol).—Annual General Meeting.

Friday, April 1

CHEMICAL SOCIETY (joint meeting with the CHEMISTRY DIVISION of the ATOMIC ENERGY RESEARCH ESTABLISHMENT, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 9.30 a.m.—Discussion on "The Use of Radioactive Tracers in Chemistry".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (in the Chemistry Lecture Theatre, The University, Highfields, Nottingham), at 3.30 p.m.—Discussion on "Electrophoretic Analysis".

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Dr. F. P. Bowden, F.R.S.: "Seizure of Rubbing Surfaces"; Dr. J. R. Bristow: "The Measurement of Kinetic Boundary Friction or the Experimental Investigation of 'Oiliness'".

ROYAL STATISTICAL SOCIETY, LONDON GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, Strand, London, W.C.2), at 6 p.m.—Mr. C. Wainwright: "Statistical Principles in Quality Specifications for Plastics".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. H. V. Potter: "Synthetic Fibres" (Jubilee Memorial Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. S. Tolansky: "The Examination of Crystal and Metal Surfaces using Interferometry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICAL CHEMISTS (Scientific Officer grade) at a Ministry of Supply Research and Development Establishment near London, for duties in (*a*) high temperature refractories, (*b*) crystallography and practical microscopy, (*c*) spectrography, and (*d*) plant development—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1025/48A (April 2).

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS (with a good honours degree, or equivalent, in physics, and an interest in photography from high-speed aircraft and in air survey photography) at the Royal Aircraft Establishment, Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.43/49A (April 2).

RESPONSIBLE LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN MATHEMATICS—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (April 2).

PHYSICISTS (Senior Scientific Officer and Scientific Officer grades) in Ministry of Supply Research and Development Establishments in South England and South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.42/49A (April 2).

SENIOR EXPERIMENTAL OFFICER in Ministry of Supply Headquarters, London, for the co-ordination of thermionic valve requirements and supervision of an information service on valves for Government Departments and associated organisations—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.69/49A (April 2).

LECTURER (qualified to teach up to B.Sc. general degree standard in Mathematics) IN THE PHYSICS AND MATHEMATICS DEPARTMENT—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (April 2).

SENIOR ASSISTANT IN PHYSICS at the Bradford Technical College—The Director of Education, Town Hall, Bradford (April 2).

VENTILATION ENGINEER in the Production Department at the Board's Headquarters in London—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/126 (April 4).

LECTURER (Grade IIb) IN INDUSTRIAL METALLURGY—The Secretary, The University, Birmingham 3 (April 9).

ENGINEERS or PHYSICISTS IN THE HYDRAULICS RESEARCH ORGANIZATION (Department of Scientific and Industrial Research) for work in connexion with the design and development of new instruments for hydraulics laboratory and oceanographic research—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.51/49A (April 9).

PRINCIPAL SCIENTIFIC OFFICER (Ref. F.134/49A) to be responsible, under the Superintendent, for research on chemical, physical and engineering problems of flax cultivation and processing, a SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (Ref. A.36/49A) for research in connexion with fibre grading and testing, etc., a SCIENTIFIC OFFICER (Ref. F.135/49A) to undertake research into some aspects of chemical and biological retting, etc., a SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (Ref. F.136/49A) to take charge of the chemical testing and analytical section, and an EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (Ref. A.37/49A) to take charge of the technical library and information section, at the Norfolk Flax Establishment, King's Lynn—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 9).

DIRECTOR OF THE MARINE BIOLOGICAL STATION which is being established at Bangor to develop the facilities for the study of Marine Biology within the University of Wales—The Secretary and Registrar, University College of North Wales, Bangor (April 9).

LECTURER IN AGRICULTURAL ZOOLOGY—The Secretary of University Court, The University, Glasgow, W.2 (April 12).

SENIOR BIOCHEMIST to direct the research activities of a cell metabolism unit at the Australian Institute of Anatomy, Canberra—The Chief Medical Officer, Australia House, Strand, London, W.C.2 (April 14).

LECTURER IN PHARMACOLOGY—Prof. J. H. Gaddum, Pharmacology Department, The University, Edinburgh (April 15).

ASSISTANT IN THE DEPARTMENT OF NATURAL PHILOSOPHY, University College, Dundee—The Secretary, The University, St. Andrews (April 15).

LECTURER (Grade III) IN GEOGRAPHY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (April 22).

CHEMIST to assist in research with radioactive isotopes—The Secretary and House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (April 22).

LECTURER IN ANIMAL HUSBANDRY AND MANAGEMENT, and a LECTURER IN PATHOLOGY AND BACTERIOLOGY, in the Veterinary School, Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (April 23).

PRINCIPAL (woman)—The Secretary, Studley College, Warwickshire (April 29).

POST-GRADUATE STUDENTSHIPS (3) for research into stored products entomology in the Colonial Empire—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (April 30).

I.C.I. RESEARCH FELLOWSHIPS in bacteriology, biochemistry, chemical engineering, chemistry, chemistry of leather manufacture, chemotherapy, colloid science, colour chemistry and dyeing, engineering (civil, electrical or mechanical), fuel and refractories, metallurgy, pharmacology physics, textile industries (protein chemistry)—The Registrar, The University, Leeds 2 (April 30).

LECTURERS IN CHEMISTRY (special qualifications in physical chemistry required for one post and in technical chemistry for the other)—The Secretary, The University, Edinburgh (April 30).

LECTURERS and SENIOR LECTURERS IN PHYSICS—The Secretary of University Court, The University, Glasgow, W.2 (May 31).

NUFFIELD RESEARCH STUDENTSHIPS AND FELLOWSHIPS for experimental and theoretical research in nuclear physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 31).

RESEARCH FELLOWSHIP IN METALLURGY—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 1).

SCIENCE GRADUATE, for bureau literary work—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey.

SENIOR PHYSICIST to take charge of the researches on the physical aspects of rubber science and technology—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.

SENIOR TECHNICIAN (special knowledge of V.D. pathology essential)—The Pathologist, London Hospital Whitechapel Clinic, London, E.1.

LECTURER (up to B.Sc. standard) IN MATHEMATICS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

PHYSICAL CHEMIST or PHYSICIST for research on the manufacture, properties and use of whiting, and an INFORMATION OFFICER to deal with library, abstracting and information services—The Director of Research, British Whiting Research Laboratories, 235 Ampthill Road, Bedford.

LECTURER IN BOTANY—The Registrar, University College, Exeter.

ASSISTANT DIRECTOR OF THE GAME AND TSETSE CONTROL DEPARTMENT, Government of Northern Rhodesia—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

CHIEF or SENIOR TECHNICIAN to take charge of the biochemical laboratory—The Chemical Pathologist, Hospital for Sick Children, Great Ormond Street, London, W.C.1.

LECTURER, and two ASSISTANT LECTURERS AND DEMONSTRATORS (one part-time) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

UNIVERSITY GRADUATE (with first- or second-class honours in botany) for bracken investigations—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

LABORATORY ASSISTANT IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, University College, Gower Street, London, W.C.1, endorsed 'Biochemistry/2'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The W. H. Ross Foundation (Scotland) for the Study of Prevention of Blindness. Pp. viii+236. (London: University of London Press, Ltd., 1948.) 3*s*. net. [309

List of Recorded Cotton Insects of the World. By H. Hargreaves. Pp. 50. (London: Commonwealth Institute of Entomology, 1948.) 5*s*. [510

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 834, Vol. 241: Systematic Sampling. By Dr. F. Yates. Pp. 345–377. (London: Cambridge University Press, 1948.) 8*s*. 6*d*. [510

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper, No. 11: The Effect of the Soil Foundation on the Road Surface; an Outline of Existing Knowledge. By D. J. Maclean. Pp. iv+20+16 plates. (London: H.M. Stationery Office, 1948.) 1*s*. 3*d*. net. [710

Radio Valve Practice. Pp. 24. (London: British Radio Valve Manufacturers' Association, 1948.) [710

Fair Isle Bird Observatory. Pp. 15+16 plates. (Edinburgh: Scottish Ornithologists' Club, 1948.) [710

London County Council. Oxidation-Reduction Potentials in Bacteriology and Biochemistry. By Dr. L. F. Hewitt. Fifth edition. Pp. 130. (London: Staples Press, Ltd., 1948.) 4*s*. 6*d*. [1110

Medical Research Council. Memorandum No. 21: List of Species maintained in the National Collection of Cultures. Pp. iv+17. (London: H.M. Stationery Office, 1948.) 9*d*. net. [1110

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 835, Vol. 241: Large-Elastic Deformations of Isotropic Materials, 4, Further Developments of the General Theory. By R. S. Rivlin. Pp. 379–397. (London: Cambridge University Press, 1948.) 4*s*. 6*d*. [1110

Ministry of Agriculture and Fisheries. The Mites Associated with Stored Food Products. By A. M. Hughes. Pp. iii+168. (London: H.M. Stationery Office, 1948.) 3*s*. net. [1310

Nuffield Foundation. Report of the Trustees for the Year ending 31 March 1948. Pp. 92. (London: Nuffield Foundation, 1948.) [1310

Standing Commission on Museums and Galleries. Third Report. Pp. 52+12 plates. (London: H.M. Stationery Office, 1948.) 1*s*. 6*d*. net. [1910

Department of Scientific and Industrial Research (Building Research Station). National Building Studies, Bulletin No. 3: Concreting and Bricklaying in Cold Weather. By A. J. Newman. Pp. iv+14. (London: H.M. Stationery Office, 1948.) 6*d*. net. [2610

Other Countries

Commonwealth of Australia. Twenty-first Annual Report of the Council for Scientific and Industrial Research for the Year ended 30th June 1947. Pp. 139. (Canberra: Commonwealth Government Printer, 1948.) 6*s*. [210

Union of South Africa: Department of the Interior, Archæological Survey. Early Man in the Vaal River Basin. Part 1: The Earlier Stone Age or Old Palæolithic Industries in the Vaal River Basin, by Henri Breuil; Part 2: The Older Gravels of the Vaal, by C. van Riet Lowe; Part 3: Note on the Older Gravels of the Vaal between Barkly West and Windsorton, by Alex. L. du Toit. Pp. 35. (Pretoria: Government Printer, 1948.) 5*s*. [320

Proceedings of the California Zoological Club. (Published irregularly.) Vol. 1, No. 1, August 1, 1948. Pp. 8. (Stanford University, Calif.: California Zoological Club, 1948.) 5 dollars per vol. [220

Smithsonian Institution: Freer Gallery of Art. Occasional Papers, Vol. 1, No. 2: Paintings, Pastels, Drawings, Prints and Copper Plates by and attributed to American and European Artists, together with a List of Original Whistleriana, in the Freer Gallery of Art. By Burns A. Stubbs. (Publication 3905.) Pp. vi+152+20 plates. (Washington, D.C.: Smithsonian Institution, 1948.) [220

Tanganyika Territory: Department of Lands and Mines, Geological Division. Short Paper, No. 29: The Geology of the Country around Mwanza Gulf. By G. M. Stockley. Pp. 25. (Dodoma: Department of Lands and Mines; London: Crown Agents for the Colonies, 1947.) 3*s*. [220

Forest Administration Plan, Nigeria, 1946–55, under a Ten-Year Plan of Development for Nigeria, 1946. Pp. 42. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1948.) 9*d*. [220

Smithsonian Institution: Bureau of American Ethnology. Bulletin 143: Handbook of South American Indians. Edited by Julian H. Steward. Vol. 3: The Tropical Forest Tribes. Pp. xxvi+986+126 plates. (Washington, D.C.: Government Printing Office, 1948.) [510

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 1, Band 25, No. 1: On the Morphology and Taxonomy of the Middle Devonian Osteolepid Fishes of Scotland. By Erik Jarvik. Pp. 301+37 plates. Serien 3, Band 25, No. 2: Spectra, Magnitudes and Colours of Stars in Regions of Different Galactic Latitude. 1: +2½° Galactic Latitude. By Carl Schalén. Pp. 42. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd. 1948.) [510

Report of the Caribbean Commission to the Governments of the French Republic, the Kingdom of the Netherlands, the United Kingdom, the United States of America, for the Year 1947. Pp. 32. (Port of Spain, Trinidad: Caribbean Commission, 1948.) 25 cents. [510

Science and Engineering. (Organ of Indian Society of Engineers.) Vol. 1, No. 1, July 1948. Pp. iv+16. (Calcutta: India Society of Engineers, 1948.) 1 rupee, 2*s*.; annual subscription, 8 rupees, 15*s*. [510

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 23, Memoir No. 2: Brachiopoda and Mollusca from the Productus Limestones of the Salt Range. By Dr. F. R. Cowper Reed. Pp. xii+596+65 plates. (Calcutta: Geological Survey of India, 1944.) 63.2 rupees; 96*s*. [510

A Bibliography of British Somaliland. By Major N. M. Viney. Pp. 36. (Burao: General Survey, 1947.) [710

Carlsberg Foundation's Oceanographical Expedition round the World 1928–30 and previous *Dana* Expeditions. *Dana* Report, No. 29: The Thecosomatous Pteropods, 2, The Indo-Pacific. By J. J. Tesch. Pp. 45+3 plates. 10 D.kr.; 10*s*. *Dana* Report, No. 31: *Chauliodus* Schn., Bathypelagic Genus of Fishes; a Systematic, Phylogenetic and Geographical Study. By Vilh. Ege. Pp. 148+2 plates. 32 D.kr.; 33*s*. (Copenhagen: C. A. Reitzels Forlag; London: Oxford University Press, 1948.) [710

Coryndon Memorial Museum. Occasional Papers, No. 2: Dimple-based Pottery from Central Kavirondo, Kenya Colony. By M. D. Leakey, the late W. E. Owen and L. S. B. Leakey. Pp. 43+8 plates. (Nairobi: Coryndon Memorial Museum; Cambridge: Deighton Bell and Co., Ltd., 1948.) 5*s*. [710

Annals of the New York Academy of Sciences. Vol. 49, Art. 5: Recent Studies in the Mechanisms of Embryonic Development. By E. J. Boell, D. P. Costello, S. R. Detwiler, G. Fankhauser, J. Holtfreter, J. S. Nicholas, S. M. Rose, D. Rudnick and L. S. Stone. Pp. 661–868. (New York: New York Academy of Sciences, 1948.) 3.50 dollars. [1110

Catalogues

MSE 'Ato-Mix' Blender and Disintegrator. (Leaflet No. 130.) Pp. 2. MSE 'Chemical' Centrifuge. (Leaflet No. 122.) Pp. 2. (London: Measuring and Scientific Equipment, Ltd., 1948.)

Transmitting and Power Rectifying Valves. (Ref. SP.7/2.) Pp. 8. Receiving and Rectifying Valves (Ref. SP.8/2.) Pp. 12. Transmitting Valve Type D.E.T.17. (Ref. A.1/8.) Pp. 6. (Chelmsford: Marconi's Wireless Telegraph Co., Ltd., 1948.)

Voyages and Travel, Colonial and Dominion History, Slavery, Naval History, Ships and Shipping, Maps and Atlases, Jesuit Relations, Native Races and their Customs, etc. (Catalogue No. 691.) Pp. 120. (London: Francis Edwards, Ltd., 1948.)

Old Science, Part 1. (Catalogue 12.) Pp. 54. (London: E. Weil, c/o National Provincial Bank, 9 Market Place, N.W.11, 1948.)

Introductory Notes on Chromatography. Pp. 40. (Poole: British Drug Houses, Ltd., 1948.) Free.

Standard Stock Sizes: Aluminium, Brass, Copper and other Non-Ferrous Metals. Pp. 48. (London: H. Rollet and Co., Ltd., 1948.)

Muirhead Picture Telegraphy. Pp. 12. (Beckenham: Muirhead and Co., Ltd., 1948.)